.EXE

JULY 1993 VOL 8 ISSUE 2

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The Software Developers' Magazine

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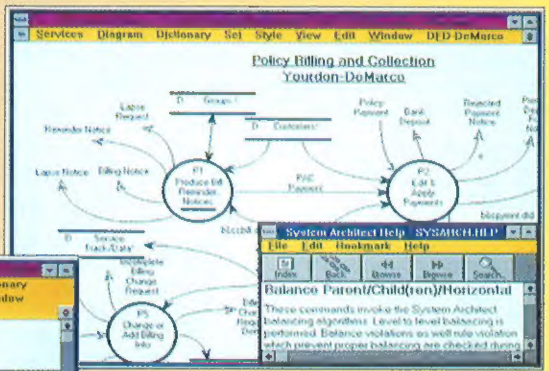

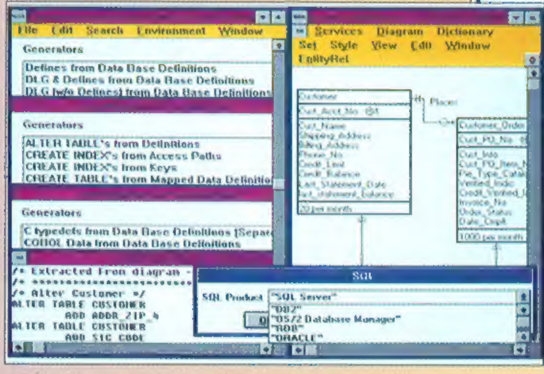

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Editorial

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Pronunciation

.EXE Magazine rhymes with 'not sexy magazine'.

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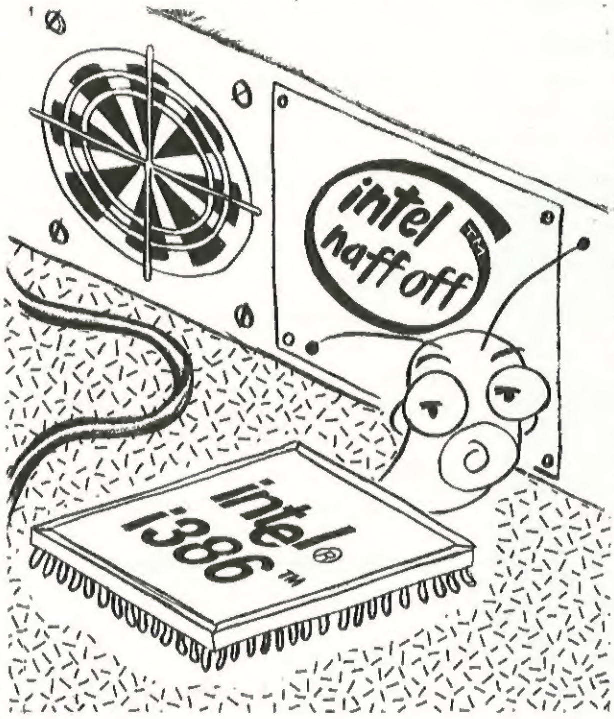
Issue theme: Networks and Communications

Intel Outside

Intel is king of the PC industry. But for how long?

Three months ago we witnessed the launch of a new microprocessor. Mind you, this was no ordinary microprocessor. This was the Pentium, destined to take Intel's x86 architecture well into the late 90s. Destined to give levels of price/performance as yet unheard of, opening the floodgates to software of immense complexity and new types of application... All from a core architecture which was first devised in 1978, when Sid Vicious was doing his thing.



While we are willing to tell others how quickly we adopt innovative new technology, fact is, we're a stubborn lot, opting for compatibility rather than seeking out better (although, possibly incompatible) alternatives. We are still writing 16-bit applications; still juggling 64 KB segments and still using an operating system which gives only 640 KB of conventional memory in which to run our code. Of course, I'm speaking of the PC market and MS-DOS. With over 100 million machines world-wide, it isn't surprising we're reluctant to change. The possibility of writing software for the masses has inhibited the evolution of the PC. None of Darwin's theory applies here - this is survival of the couch potato.

But things are about to change. Despite the phenomenal success of Window 3.x, it is *only* a 16-bit, single-threaded GUI, sitting on top of good old DOS - a DOS enhancer. But its successor, Windows NT, is likely to change both the software and the hardware side of the PC industry for good. For the hardware designer it offers a break away from the x86 architecture. And for software developers, there's a flat 32-bit address space in which to write multi-threading applications.

Remember the ACE consortium? Set up by Microsoft, SCO and MIPs to promote software compatibility between RISC and CISC architectures across Windows NT and SCO UNIX platforms. It was generally perceived as an anti-Intel alliance. We haven't heard much from ACE recently - but surely the new MIPs R4000 and DEC Alpha PCs are its first protégés.

Notice I said MIPS and DEC PCs, not workstations. The workstation has always been synonymous with 'high-end', high performance UNIX machines. The PC, on the other hand, is a low-cost general purpose machine. Not only do workstations command a high price tag, the software they run tend to fit into the mega-bucks price bracket. By comparison, PC software is cheap, period.

If NT is successful, the division between workstation and PC will become disappear. Users won't be forced to pay a premium for running the R4000 or Alpha version of their favourite DTP, word processing, database or spreadsheet package. Already the big names, including Lotus, WordPerfect and Borland are committed to releasing NT versions of their packages.

So how will the launch of NT affect Pentium sales? Will there be a mass exodus from the Intel camp to either DEC or MIPs? Intel says it isn't concerned. It plans to maintain its dominance in the mass market - with what, in effect, is an inferior product. The people who will initially buy these machines are looking for cutting-edge performance (eg for CAD). Why would they opt for a 66 MHz Pentium PC when a similarly configured 150 MHz DEC Alpha will cost about the same? Intel maintains that the overall cost of manufacturing a 150 MHz Alpha chip is far more than that of the 66 MHz Pentium. But since Intel is only shipping 10,000 units this year, there is still time for DEC and MIPs to establish themselves. The designers at Intel would be foolish to think their domination of the mass market will continue unchallenged.

Of course, there has always been competition. In the mid-1980s the 8086 and the NEC V20 fought over the PC market. A direct attack on the 486 is imminent with the arrival of AMD's long awaited 486-clone, despite Intel's successful copyright suit against AMD. The AMD386 was faster and cheaper than the Intel386. We expect history will repeat itself. Cyrix, too, is hacking away at Intel's virtual monopoly of the x86 market. But both companies plan Pentium-compatible processors for the future, the most serious threat to Intel is from MIPs and DEC.

I believe we are we witnessing the end of Intel's reign over the PC industry. The time for abandoning the x86 architecture is long overdue. We now have 64-bit processors and 32-bit operating systems. Why restrict our software to 16-bit compatibility?

CS

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NEW PHAR LAP 386IDOS-EXTENDER SDK 5.0 lets you use the Microsoft Windows NT 32-bit C/C++ compiler for 32-bit Extended-DOS development. It offers the full functionality of the 16-bit Microsoft C/C++ DOS run-time libraries, including graphics. It also includes a new source level debugger - ONLY £395

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We stock many items for which there is no space in these advertisements.

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NEW VISUAL BASIC 3.0 FOR WINDOWS STANDARD now includes the Access 1.1 Database Engine and full OLE 2.0 support. The Access engine provides robust multi-user support, true transaction processing, optimistic & pessimistic locking, support for a wide range of data types including sound, video, OLE objects, pictures etc, distributed joins, updatable queries, query optimisation and support for Access, FoxPro, dBase, Paradox and Btrieve files. The engine is accessed visually through a new Data Control which handles the query and new data-aware controls such as TextBox, CheckBox, Picture etc which can be bound to a query without writing code. ONLY £95 (upgrade from VB2 Standard for £39).

NEW PROFESSIONAL EDITION adds a programmatic data-access layer to control the engine directly (variables of type Database, Table, Dynaset etc may be declared in Visual Basic), full ODBC support including scrollable cursors and drivers for SQL Server and Oracle, Crystal Reports for Visual Basic (with royalty-free print engine), additional data-aware controls (Masked Edit, 3D Panel & 3D Check Box), a new Outline Control for hierarchical list-boxes as in File Manager, and a new version of the Control Development Kit for creating data-aware custom controls. ONLY £222 (upgrade from VB2 Professional for £59).

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News & Views

Visual Basic 3.0 for Windows is the most significant announcement this month, both for its influence and expected sales. The Access Engine is the most attractive new feature - a fully featured relational database engine which can be accessed either visually with data-aware custom controls and the data control or directly in code by declaring variables of types such as Database, Table, Dynaset, Querydef etc and performing operations on them. 12 months ago, Microsoft had minimal presence in the database market, whereas in 12 months time, the Access engine could be the most widely used database tool on Windows. Let's wait and see.

In the longer term, the support for OLE 2.0 will probably be more significant. It will enable anyone to write applications which can incorporate OLE 2.0 applications such as word processors and spreadsheets. OLE 2.0 Automation is the magic bit - it lets you send messages, set properties or execute methods on OLE 2.0 defined objects. You simply declare a variable of type Object in your program, set it to an OLE object such as Word.Document and control it directly. If an OLE 2.0 object supports in-place editing as well as OLE Automation, it is effectively a control. This will open a massive market for OLE 2.0 developers - assuming it all works as well as Microsoft says that it does!

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Microsoft Windows 3.1	**£70**
MS Windows SDK 3.1	**£165**
Borland C++ 3.1	**£250**
Borland C++ & AFX 3.1	**£365**
Borland Pascal with Objects 7.0	**£250**
dBase IV 1.5	**£415**
Paradox Engine & DFX 3.0	**£125**
Turbo C++ 3.0	**£59**
Turbo C++ Visual Ed. for Win	**£52**
Turbo Pascal 7.0	**£84**
Turbo Pascal for Windows 1.5	**£99**
Paradox 4.0	**£415**

WITH FULL TECHNICAL SUPPORT

AM386 Attacked

Intel is continuing its legal assault on AMD. A Court ruling six months ago delayed introduction of the AM486. Now Intel has won the next round. The Californian Court of Appeals for the Sixth District has recently ruled against AMD over its rights to Intel386 technology, used in the AM386 microprocessor. Intel is now planning a separate federal suit against the AM386. Intel predicts damages against AMD will be over $600 million.

60 days to go...

On 24th May Microsoft formally unveiled Windows NT. The first batch is expected to ship within 60 days of this announcement. In his speech, Bill Gates suggested that: '[Windows NT] represents a fundamental change in the way all companies can address their computing requirements.' Experiencing such a change will set you back a cool £399 (£249 upgrade from Windows 3.x or OS/2).

Icicle

New York based ImageSoft has put together a library of public domain and shareware C++ source called ISCL (pronounced 'Icicle'). It includes the GNU 386 C++ compiler, a comms library, maths and matrix classes, DPMI programming kit, classes for Btrieve and Paradox and a C++ class library for building GUIs. ISCL costs £85 from SystemStar (0992 500919).

Higher C

MetaWare has introduced a new version of its High C/C++ DOS/Windows compiler which has been optimised for the Pentium. It features instruction scheduling, inlining and loop strength reduction global optimisations. High C/C++ V3.1 for Extended DOS and Windows 3.1 costs $795. MetaWare is on 0101 408 4296382.

VBW support in GFA

The recently introduced GFA-Basic for Windows V4.3 offers enhanced support for VBW programmers. Unlike VBW, GFA-Basic is able to generate native compiled code for writing standalone executables and DLLs. One of the new features is VB, *a command which gives a GFA-Basic DLL the ability to call a routine in a VBW executable which loads it. The GFA-Basic Interpreter costs £170; the compiler, £42.55. Both are available direct from GFA Data Media (0734 794941).*

MS Database Tools

Microsoft is offering FoxPro developers three new tools. The Distribution Kit is available for both DOS and Windows versions of FoxPro, allowing developers to compile DOS or Windows FoxPro applications for royalty-free distribution. It comes with a version of Setup Wizard, the Windows Help Compiler, an online version of The Windows Interface Design Guide and a run-time version of Microsoft Graph. Both the DOS and the Windows versions are priced at £199 each.

The Library Construction Kit enables C programmers to extend FoxPro by writing Windows FoxPro Linked Libraries (.FLLs) or DOS-based FoxPro libraries (.PLBs) which are source code compatible. Microsoft claims that a .PLB may be compiled under Windows with minimal change. Also new: event-processing books, low-level keyboard/mouse control and direct database access. The FoxPro Library construction kit costs £395.

Microsoft's other Windows database has been upgraded. New features to Access V1.1 include ODBC support for Oracle and Sybase and the ability to read and write FoxPro V2.0 and V2.5 data and index files 'on the fly'. Also available is the Access Distribution Kit which comes with a run-time version of Microsoft Access, for royalty-free distribution of applications.

Microsoft is asking £14.95 to upgrade existing Access users to the new release. The Access Distribution Kit costs £395. Microsoft is on 0734 270000.

Maths Class

There's a new version of Meijin++, the C++ numeric class library from Network Integrated Services. Bearing in mind I'm someone who flunked Maths A'Level, I won't attempt to explain all its features. But I did recognise a few of the classes it offered. From the comprehensive list I encountered a few familiar acquaintances like Euler and Newton-Raphson; old foes among the trigonometric, hyperbolic and polynomial functions and, from glorious Stats, the Normal, χ^2, Poisson and Binomial distributions.

Meijin++ also provides: linear regression, Fast Fourier transform, filtering, moments and matrix operations. And some linear sorts and container classes.

All of this needs documentation - 940 pages worth and 200 sample programs, along with case studies and maths theory. The DOS version is priced at £749 (£1196 for UNIX) from Hypersoft (0273 834596).

Boost for OS/2

IBM has introduced a new version of OS/2 to answer some of the criticism of the V2.0 release. First, Windows 3.1 support has been added. If you recall, Microsoft released this version of Windows about the same time IBM had got V2.0 out of the door, rendering Windows 3.0 compatibility obsolete. The new OS/2 can also run Windows Enhanced Mode applications, unlike its predecessor which only offered Standard Mode compatibility.

The long awaited 32-bit graphics engine has finally been added. So has support for SVGA screen modes up to 1024 x 768 in 256 colours. 32-Bit drivers for several chipsets including Tseng, ATI and Trident are provided. Both Windows and OS/2 applications can run at full resolution on the same screen using a technology called 'Seamless Windows.'

IBM says it has improved the overall performance. In particular, users should notice an improvement in the speed of the WorkSpace Shell (ie faster opening/closing of folders and painting of icons). Minimum system configuration has also relaxed. When V2.0 was first introduced, IBM recommended a 386SX-class machine with 6-8 MB memory as the base minimum. But nobody could achieve anything near acceptable levels of performance. In V2.1, a machine with 6-8 MB of installed memory is expected to offer a 'workable' system.

Here's a few of the more interesting highlights in this release: built-in multimedia which can playback digital video at 30 frames per second without additional hardware support; Adobe Type Manager Level 2.5 and TrueType fonts.

IBM is offering V2.1 at a special promotion price of £99 (diskette) or £90 (CD-ROM) until the end of September. Upgrades from V2.0 start at £60. Details are available from the IBM Personal Systems Enquiry Centre on 0256 841818.

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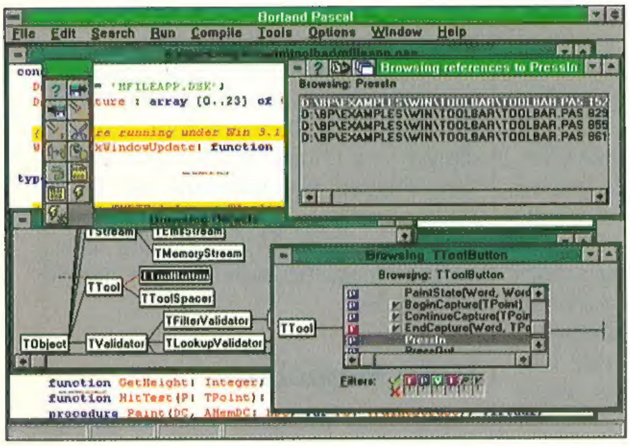
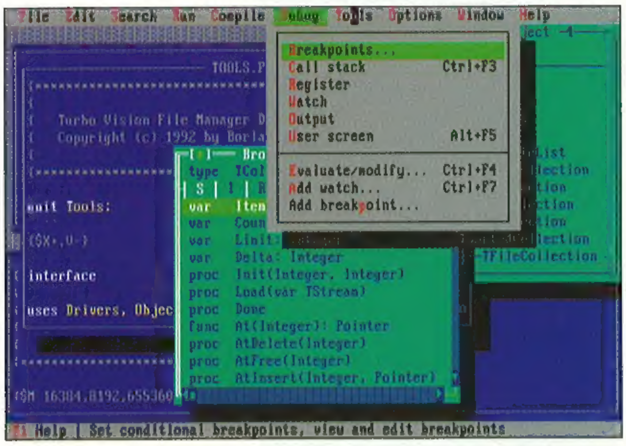


Borland Pascal 7.0



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► CIRCLE NO. 893

III for V

Three new add-ons for Smalltalk/V were announced at the Digitalk Developer's Conference in May. From Polmorpic Systems there's Tensegrity (£300), a network-independent object-oriented database. Objectshare Systems revealed the latest version of its WindowsBuilder Pro/V screen designer (Windows version £275). And from Tau Ceti there's WindowsBooster (£49 for Windows, £99 for OS/2), a tool for improving the speed at which dialog boxes open and close. The UK distributor is Cocking & Drury on 071 4369481.

Super Harlequin

Super Harlequin is a new graphics controller, based on a 40 MHz TMS34020 processor, from Datapath. The card comes with 4 MB of installed memory and offers screen resolutions up to 1600 x 1200 with 65536 colours, 16.7 million colours at 1152 x 900 and 1136 x 1152 using 72 Hz refresh rates are also supported. The manufacturer claims Super Harlequin obtains Wintach benchmarks of up to 136. The £1,695 price tag includes several utilities and TIGA drivers for Windows and MicroStation. DataPath is on 0332 294441.

Object Expo

Just a little reminder: make a note in your diary to keep July 12-16 free. This is when Object Expo Europe will be taking place - at the Queen Elizabeth II Conference Centre, London. According to Sigs Conferences, its organiser, Object Expo Europe is 'Europe's largest OOP conference and exhibition'. As a co-sponsor, .EXE warmly welcomes our readers. Over the five day event there will be a total of 45 lectures and keynote speeches from Apple's Larry Tesler and IBM's Cliff Reeves.

Nightmare!

Today we have the Windows desktop - running on some 20 million machines. What if the desktop grew to take over the entire office! Phones with 'easier' touchscreen interfaces (instead of the not-so-obvious buttons of today), not to mention interconnected, GUI-driven photocopiers, printers etc. Forget 'what ifs', this is an all new Gates-vision christened Microsoft At Work, with lung-busting acronyms like WYPIWYFIWYCIWYS (What You Print Is What You Fax Is What You Copy Is What You See).

Manager for VBW

ExpoTech has introduced what it claims to be one of the first project management tools for VBW. VB-Project Archiver automatically archives all code and form files used in a VBW project. It also offers version control and the ability to generate distribution files - achieved by creating an archive containing only the executable and DLLs/VBXs used by the application. Design-time custom controls are replaced by their run-time equivalents. For the special introduction price of £69.95, ExpoTech is shipping a copy of VB-Tidy with VB-Project Archiver. This is a utility which saves the layout of the VBW IDE (including code window) between VBW sessions. ExpoTech is on 0273 746346.

Soft Dial

The Voice Toolkit from Telesoft is a library which enables developers to write voice processing software for the PC. Application areas include tone-dial driven menu systems and automated switchboards, such as those available on the Borland and Microsoft technical support desks, digital answer phones and tele-banking. It will soon be possible to detect the telephone number of an incoming call. Telesoft suggests this will enable a sales person to access data such as order details for the callee even before the phone has been answered.

The Toolkit contains over 300 functions and works in conjunction with voice processing boards from Rhetorex and Aculab. In addition there is a dialogue library containing more than 300 phrases. The manufacturer says that these may be stringed together by the play engine, without incurring unnatural pauses in between phrases, to produce contiguous speech.

Voice Toolbox comes with a number of utilities for analysing and amplifying speech. Speech recordings can be stored in a library and loaded at runtime. Digital trunk standards like Euro-ISDN, DASS-2 and DPNSS are also supported. The Voice Toolkit costs £1000. Phone TeleSoft on 0272 706050 for details.

Help Magician

This year we have seen a crop of development tools for creating Windows Help files. Windows Help Magician from Software Interphase is one such product. The latest release offers a way to reference all occurrences of a specified hypertext link keyword automatically. This saves the developer from having to go through the entire Help text, marking wherever the given keyword appears. Other features include secondary windows, non-scrolling regions and the ability to assign help context IDs for context-sensitive Help. In addition, the IDE enables developers to test help files without compiling. There is also a built-in editor which can read and write .RTF files. Software Interphase (0101 401 3972340) is selling Help Magician for $199 (single-user licence).

AutoCAD++

DataSim has developed a C++ class library for writing AutoCAD applications. CADObject offers 60 geometric classes which extend the facilities provided by AutoCAD. These include classes for primitives (points and lines); shapes (triangles, rectangles, quadrilaterals); sector and regular polygons and polylines. Utility classes are provided for manipulating homogeneous and heterogeneous lists. There are also template classes for matrices and 2D/3D transformations; a string class and a measurement class (eg for converting between degrees/radians). Further classes provide an object-oriented 'shell' to AutoCAD. This enables developers to perform such tasks as inserting objects into AutoCAD, creating Bill-Of-Materials (BOM), importing ASCII data into AutoCAD and setting up links between ADS and object-oriented databases.

A number of examples of applying OOP to CAD are provided. These include classes for B-splines and beta splines; polymarkers and line style classes; graphs and histograms; motion simulation and classes of symbol libraries. DataSim aims to re-educate AutoLisp and C programmers. The first step it has taken in this direction is is to ship a course book on C++ along with the library's standard reference and user manuals. CADObject is available for Borland V3.x and Zortech V3.x C++ compilers at the special promotion price of Dfl 1,875 (Dutch Guilders), until the end of August. DataSim is on 01031 20 6240055.

SoftTools for the Job

*** NEW ***

The Dolphin C Toolkit

Microsoft and Borland programmers will find 235 useful functions all developed in response to the practical needs of professional software development by Dolphin Software of Austin, Texas.

Included are 38 Date functions. Every date in an 11 million year period is associated with a unique long int. Hundreds of date formats are supported. Time functions, disk functions, string, directory, file and printer functions, together with unusual functions including command line processing, soft reboot, ROMBIOS date and ascertaining I/O direction make this a most comprehensive and versatile timesaver for the professional. Requires DOS 2.1 or later. Included are 18 demonstration programs (source plus executable files) and a 232 page manual.
Price: £99 (source code available for £50)

Dolphin Far Memory Manager

Allows easy, effective and error free use of far memory (outside the default 640K default data segment) from within the small model. Includes reliable far memory allocation, dynamic allocation of multi-dimensional arrays in far memory, array bounds checking, representation of 2-D and 3-D arrays, extensive error checking, diagnostic information in a memory allocation log, diagnostic report upon detection of any of 27 errors and report of far heap structure. Requires Borland or Microsoft C/C++ (100% compatible with CodeView) and is supplied in small, medium and large memory models.
Price: £99 (source available for £50)

*** NEW ***

Phar Lap 286|DOS Extender™

now with support for Microsoft Visual C++ and includes 286|VMM at no extra charge

With the **286|DOS Extender** and your Microsoft C, Borland C++ or MS Fortran and **now Microsoft Visual C++** compiler, you have all the tools necessary to quickly build protected mode applications - often by relinking without making source code changes. Protected mode applications can be built that access up to 16 megabytes of memory on any DOS 80286, 386, 386SX or i486 PC. **286|DOS Extender** is also compatible with Borland's Turbo Debugger and Microsoft's linker and CodeView debugger. **Includes 286|VMM to access Virtual Memory too!**
Price: £360

SHIELD Development Products

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A toolbox library that allows sophisticated tool box controls to be created quickly and easily.

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A graphical installation program builder for creating bullet-proof install routines.

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Windows £335 OS/2 £510
System for implementing the logic behind dialog boxes in an application.

ResourceSHIELD
Windows £150 OS/2 £350
A fully integrated editing system for resource files.

KnowledgeMan

NEW - Release 3.1 from mdbs

The latest release of the **KnowledgeMan** fully integrated professional rdbms moves even closer to an event driven GUI environment. Enhancements include Compiler and User-Defined Functions, increased performance, improved system command interface, Optimized Query by Example, new Report Definition Language and Binary Large Objects.

KnowledgeMan capabilities have always gone beyond those of the competition. **Version 3.1 features and enhancements make it even easier to develop applications rapidly and without compromise.**

KnowledgeMan DOS SU - £990, OS/2 SU - £1320
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Magna*Charter* II

Build flowcharts in minutes!

Magna*Charter* II for Windows lets you build any kind of chart in minutes and includes all standard flowcharting symbols which are displayed as icons or add your own. Use the crowsfeet for database schemas. Features are accessed by drop-down menus, dialog boxes and multiple windows with a wide choice of text styles and sizes. Editing is simple 'cut-and-paste'. **Magna*Charter* II** appears as a 99x99 spreadsheet. A wide range of printers is supported as is PostScript.
Price: £160

SoftTools from TeraTech

Tools for C/C++

Ace Comparator **£85**
Intelligently compares program files showing only the important differences. **Ace** can be configured to ignore differences in white space, indentation and even comment text!. **Ace** can also compare binary files such as EXEs and OBJs.

NOW!	**£35**
E-MEM	**£89**
Virt-Win	**£225**

Tools for Visual Basic

Dazzle/VB **£225**
Dazzle adds professional sparkle to Visual Basic programs with complete image control. Display realistic images in Windows with Dazzle/VB image library then fade and wipe your pictures using one of Dazzle's many special effects.

ProMath/VB **£99**
Adds over 150 high level maths, engineering, physics and stat routines to Visual Basic. Included are trigonometric, hyperbolic, Airy, factorial, gamma, error, beta, Fresnel and Bessel functions. Also included are statistics, matrices, functions, FFTs, differential equations, curve fitting and more.

VB/Lite **£85**
Control printers, access communications and adds fast B-tree indexing and array manipulation to Visual Basic.

TeleComm ToolKit **£69**
Routines for XMODEM, MODEM7, Batch YMODEM and YMODEM batch file transfer; VT52, VT100 and ANSI-BBS terminal emulation. Baud rates up to 19200. Command processor, script language, dialling directory, autodialling, pop-up windows and status bars. Full commented BASIC source code requires QuickBASIC PDS7 or Visual Basic for DOS and 1Mb of space.

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Create Windows applications as if your job depends on it!

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Price: £360

Other Products Supported by Systemstar SoftTools:

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zApp	v 2.0 Windows NT £320
zApp	v 2.0 OS/2 £420
C-scape	DOS £390, 386 £790
Doc-To-Help	£260
ProtoView	Binary £149, Source £100
ProtoGen	£49
DataTable	Binary £75, Source £100
PharLap 386|DOS-Extender	£360

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➤ CIRCLE NO. 894

DSP Sound

Antex Electronics has introduced a sound card for the PC which it says offers '16-bit, broadcast quality stereo'. The Z1 incorporates the TMS320C25 DSP and supports several compression formats including DVI, CDI 8/16-bit PCM at real time sample rates to 44.1 KHz stereo. It is compatible with Windows 3.1, SoundBlaster and AdLib. There's a built-in SCSI controller for connecting CD-ROM machines and a 'pro-slot' for connecting external synthesisers. Z1 costs $595 from Antext (0101 310 5323092).

BarMan

No, this isn't a reference to the (empty!) crates of Newcastle Brown at Software Development. BarMan is a VBW/Visual C++ custom control for producing barcode images. A developer can set the code, code type size, font and background/foreground colours. Text can additionally be displayed with the barcode. Several coding schemes are supported including EAN, UPC, ITF, Code-39 and Telepen. BarMan Professional VBX costs £89 from dLSoft (081 5590049).

Core Reporting

WinQL, a Windows-based report generator from Core Software, is now available in the UK. The product allows users to build report queries, sort orders and screen layouts interactively. Database formats supported include Btrieve, xBASE, ObjectVision, Paradox and DataFlex. Prices start at £295. WinQL is distributed in the UK by Data Access (071 7294460)

Techno...

The West London Training and Enterprise Council (TEC) reports that a lack of adequate IT skills is hindering Britain's economic recovery. Its recent survey of employers showed shortages in system integration, application development, technical support, database design, C, UNIX and telecomms. So the recession is ***our*** *fault, is it? Call 081 5771010 to purchase the full report (£235).*

'Tis not in the bond

Shylock trades-in his abacus for a Dell Notebook in the RSC's production of The Merchant of Venice set in the 90s which opened on 3rd June at Stratford:

```
Set Currency Symbol=lb Flesh.
```

A Class for ISAM

ISAM Manager is a B+Tree/ISAM C++ class library which supports file sizes up to two billion records. There is an index-caching mechanism for reducing disk access and support for 10 indexes per data file. A utility called DDF is used to convert the structure of a data file into a corresponding class definition. ISAM Manager also comes within the FScreen screen library and a program which generates a framework C++ file from the data file definition. Nildram Software (0442 891331) is offering ISAM Manager for £29 until the end of December.

Farming

The term 'Farm' has been used recently by DEC to describe a way to achieve near-supercomputer performance using a cluster of DEC Alpha workstations. The Networked Application Toolkit does more-or-less the same thing on a PC network. According to the manufacturer Novalis: 'the toolkit lets you make use of thousands of mips that are idled away by office computers every day.' It works by allowing programmers to access network-wide shared memory and so write distributed applications.

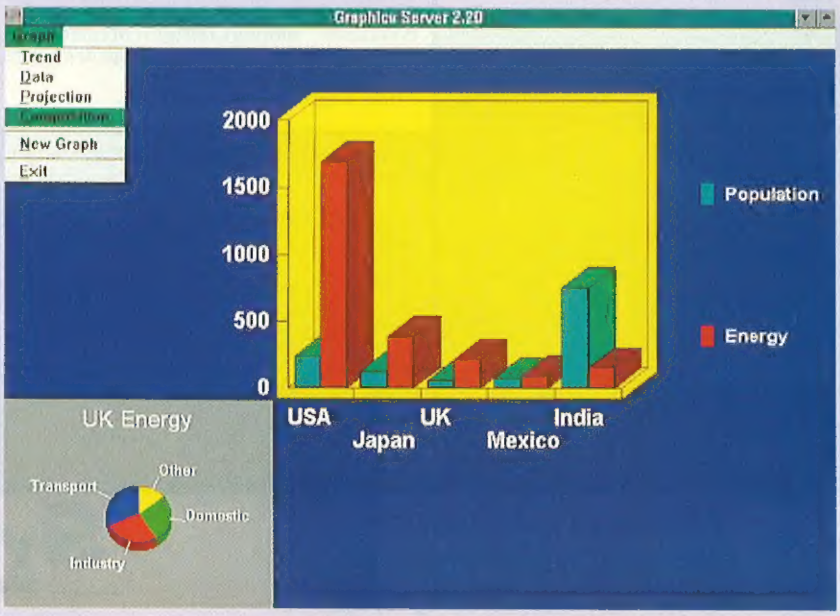
The multi-node model of distributed processing is also available. Here there may be a setup comprising several workstation 'nodes' each capable of running a particular application (or service), say a database query. When a message is sent to fire-up this service, one of the nodes will start processing.

The Networked Application Toolkit is available as a .VBX custom control for Visual Basic and as a C library at £79 each. Novalis is on 0707 328715.

Chart Lib for VC++

Graphics Server V2.20 is the next incarnation of Bits Per Second's (BPS) graphing and charting library. Highlights include a class library for Visual C++ (as discussed by John Marsh of BPS in the June '93 issue of *.EXE*) and an FLL for FoxPro. BPS says that its class library is one of the first third-party classes for Visual C++. Other features include: the ability to run code written in dGE (the company's xBASE graphing library) under Windows unmodified; several new graph types and a 'Hot Graphs' facility. This enables an application to respond to the user clicking areas of a graph or chart. In the illustration depicting energy consumption against population size, if the user clicks on the bar for UK energy consumption, a pie chart pops up showing energy sources for the UK.

This release includes the source code for the AutoGraph API, a family of high-level routines for generating graphs and charts. BPS says it is possible to open a graph window, set up titles/legends/labels and plot the data using just eight function calls. The low-level API offers 150 drawing and statistical functions. Graphics Server costs £245 and includes ChartBuilder (a cut-down version for the VBW toolbox). ChartBuilder is available separately at a cost of £85. Bits Per Second is on 0273 727119.



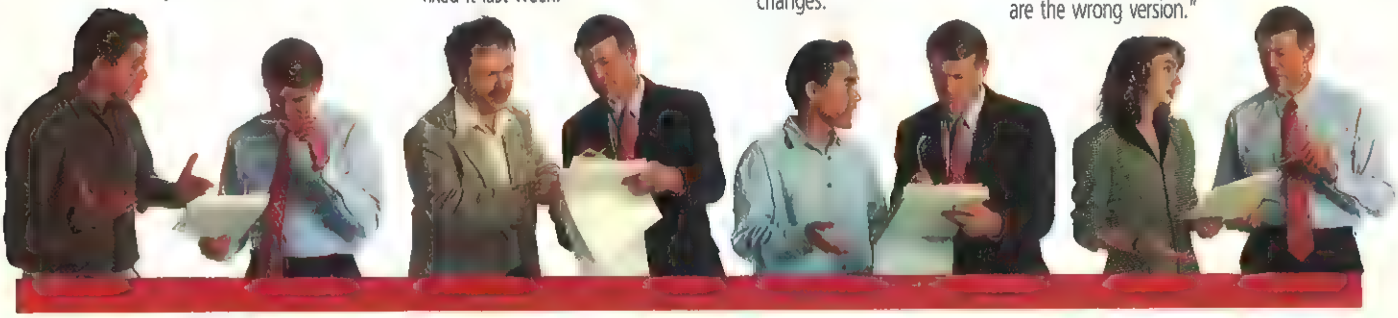
"... So I stayed up all night fixing it, and in the morning Paul saved his version and overwrote all my work."

"How did this bug get back in here - we fixed it last week."

"The auditors called - they want to know who can change our code and how we track changes."

"The demo crashed in front of the client, Fred thinks the printer drivers are the wrong version."

"WE NEED PVCS"



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The PVCS Series offers a complete solution to configuration management, that's important because development is getting more complex – not less. Implementing a partial solution today is simply creating tomorrow's problem.

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New Windows / OS/2 GUI Version 5.1

➤ CIRCLE NO. 895

Letters

We welcome letters on subjects of interest to our readers. Please write to The Editor, .EXE Magazine, 10 Barley Mow Passage, Chiswick, London W4 4PH. Unless your letter is marked 'Not for Publication', it will be considered for inclusion on this page.

Flattening May #1

Sir,

I was brought up to believe that 65536 + 1 = 0, that neither the Earth nor memory is flat, and that all programs, no matter how trivial, should make frequent use of multiple stacks, multiple heaps and overlays. Jules May is to be applauded for seizing the initiative and setting a most excellent example in championing the cause of segmented architectures *(Mayhem, .EXE June '92).*

I have always admired the cleanliness of Intel's *80x86* architecture, but I still feel that there are not enough memory models to satisfy DOS developers: `RARE`, `WELL_DONE`, `BIJOU` and `HUMUNGOUS` would be obvious additions to the stable. A true 8-bit model is conspicuous by its absence - every skilled software engineer knows that well-designed data structures can be implemented in under 256 bytes - and so I would propose that a `MICROSCOPIC` memory model is added below `TINY`.

My recent move to 32- and 64-bit systems has proved to be something of a culture shock. The `near`, `far`, `huge`, `NEAR`, `__far` and `_somewhere_in_memory` tokens are not available and so I am strait-jacketed into using portable C/C++ features. Without the challenge of coördinating a cocktail of third party software, to compensate for the machine and its operating system, I have been left with more time to develop software.

The implications on job security, of not kludging the code to fit the architecture, are both worrying and intolerable. The flat earth bandwagon must be stopped.

Kelvin Henney
Bristol

Flattening May #2

Sir,

I read Jules May's comments on Windows NT with considerable interest, not least because they virtually coincide with my own. It is undoubtedly true that the marketing-led imposition of these complex and resource-hungry systems, the steep learning curve that they imply and lack of platform stability that they represent is a considerable problem to developers. However, I must take issue with him over the desirability of a 'flat' memory architecture.

It is true that segmentation of itself is not a negative feature in a computer system, being useful for techniques such as Jules May describes: multiple small allocations, debugging firewalls etc. But as soon as the segment size is perceived as inadequate to fit some data construction for which there is otherwise ample memory, the situation is very, very different. Whether the programmer codes a solution directly or uses a facility supplied with the development toolset, the result is an artificial structure imposed on the data which reflects the underlying segmentation; such systems are difficult to comprehend, debug and maintain, inefficient in their use of processor time and may present porting difficulties.

I believe that a 'flat' memory addressing model is a genuine step forward and, once supported by the processor hardware, is a vital feature to embrace in any operating system, NT or otherwise. Despite the hype, cost and complexity, NT does at least offer the PC platform a memory contiguity which 68000-based machines have permitted from Day 1.

PR Collins
Software Development Manager
Stag Programmers Ltd
Herts

Not fooled

Sir,

Mike Mitchell *(Soapbox, June 1993)* states that he has a foolproof method of installing software packages. It is a brave man who claims in print that *any* software system is foolproof, far less one that clearly isn't.

Mike recounts problems with installations not detecting insufficient disk space and copying to directories without checking that they exist. These are problems of program logic which cannot be solved by a different method of starting the program. The only solution is more careful design and analysis.

Furthermore, how does he propose to load programs onto my hard disk when booting with his CONFIG.SYS? How will he know what compression software I may be using? How does he know whether I need to load a driver for my SCSI disc?

Without a doubt, we need to see much better installation procedures - but self-booting disks is not one of them.

Ian Cargill
Surrey

Prooofing Prublems

Sir,

I very much enjoyed June '93 *.EXE*, especially the STOB article. It was with much interest that I read Dan O'Brien's article on zApp Application Frameworks, which was very good and made zApp sound quite appealing. However, when I reached the figures showing zApp screen I got a little bit confused:

A) The Figure headings - Figure 3c, Figure 3b, Figure 3c and Figure 3d. Two Figure 3cs - how nice!

B) Figures 3c1, Figure 3b and Figure 3c2 all show the country as United States, the currency symbol as '$'. The sample boxes for all of these also show '$' as currency, all well so far. In Figure 3d, however, the country was still set as the United States, the currency was set at a '$' but the samples had a '£' next to them, oops!

This unfortunately let down an otherwise very good article.

Mr P Williams
Analyst Programmer
Ericsson Data UK Ltd

We apologise for the cock-ups Mr Williams mentions, and for three others that a superficial glance through the article revealed to me (but only after it was printed, natch). We are, after all, the magazine whose proofing even the legendary Gruaniad *mocks! Anybody interested in a spot of charity proofreading? - Ed.*

Letter of the Month

The writer of the letter of the month, as judged by the Editor, will receive a £20 book voucher, courtesy of Just Computer Books. The best letter is the one printed first. Please note that letters submitted to this page may be edited.

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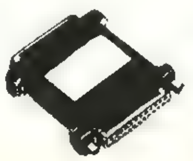

➤ CIRCLE NO. 897

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➤ CIRCLE NO. 898

And the winner is...

Who did you vote for? Willie Watts presents the results of the .EXE Software Development Awards 1993, and reveals his Editor's Choice.

As the more observant of you will have noticed: this year, in conjunction with that noblest of brews *Newcastle Brown Ale*, we initiated the *.EXE* Software Development Awards, to be presented to the manufacturers of the best software development tools.

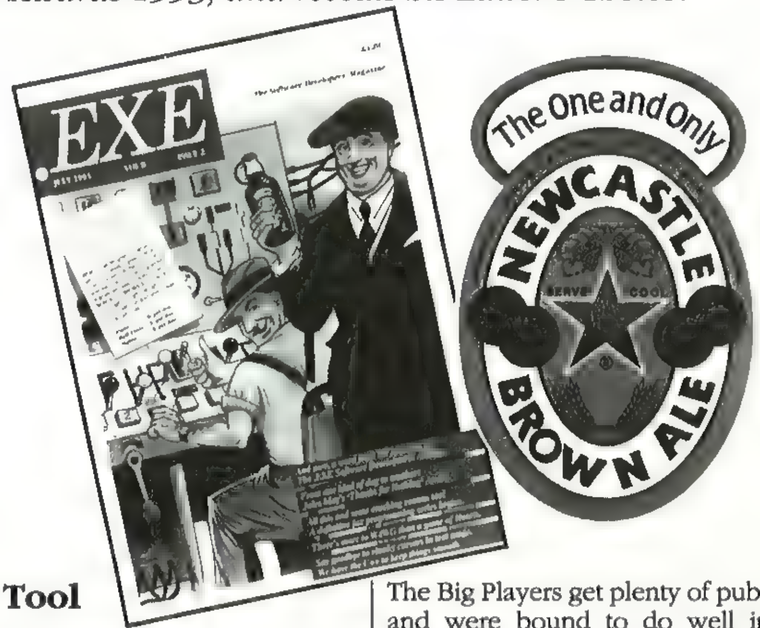
The awards have been made in three categories. *Best Compiler* and *Best Software Development Tool* were selected by the votes of readers; the other, *Editor's Choice*, was 'in my gift' as the saying goes. As a prize, a representative of each of the winning companies has received (if all went well) two crates of the aforementioned beer to dispose of as he sees fit.

We received just under 200 nominations (ok, 178) for the Reader categories, so many thanks to all those who bothered to vote, and a long drawn out raspberry to the rest. The three winners of lifetime subs are Peter Wippell, M Russell and Dr R Whitaker.

Best Compiler

This category - like the other two - is dominated by C++, which now seems to have matured to the point where people are using it sufficiently to have opinions, instead of leaving it on the shelf and worrying about it. Of the other languages, not one cracked the 2% mark (3 votes): not the various Basics (possibly because the question was worded badly; I perhaps should have said 'Language Implementation' rather than 'Compiler') nor the xBASEs nor even the Pascals.

So the action was all in C and C++, and mostly 'mainstream' manufacturers. Symantec/Zortech, once king of all things C++, picked up five votes for its DOS/Windows effort. Microsoft's new Visual C++ picked up 12%, but was beaten off by GNU C/C++, with 16% (this was the firm favourite of those few who voted by email on CIX). But the easy - and majority - winner was **Borland C++ 3.1**, which picked up a massive 54% of the votes.



Best Tool

Rather predictably, this section was much more fragmented - about 60 different tools got nominated. If a product had two votes, it was doing well. Quite a few named their favourite editors (whether it be Brief or Elvis), or their favourite UNIX tools. A couple of people named OS/2 2.0 in this category. GNU's implementations of grep, yacc etc again showed well - if the GNU camp had organised itself to vote for a single tool, it would have stormed it. The Zinc C++ class libraries also managed to get its head above the parapet.

But the winner, riding on the back of the Microsoft Visual C++ compiler vote, was the bundled tool/library package (**ClassWizard, AppStudio and MFC 2.0**). All but one who voted for Visual C++ also voted for these tools; but only a couple of those who voted for Borland C++ voted for *its* tools and class libraries.

My Choice

It's said to be foolish to explain one's actions in this situation; but there again, it's fairly rotten to produce a result out of thin air without any justification: so here's a summary of the agonising which brought me to my selection.

The Big Players get plenty of publicity, and were bound to do well in the voted awards, so to limit the range and even the score I decided to focus on the products of the smaller outfits.

I was tempted by a product called Clip-4-Win, because it managed what I believed was impossible (allowing Clipper to be a Windows compiler) - but rejected it because it was intrinsically something of a kludge, however ingenious. I thought about a couple of editors that I use (I'm not telling which), but decided I couldn't justify choosing either in the face of the screams of rage from those who happen to use some other one. I thought about the Multiscope debugger (whose user interface shows us where CodeView belongs - unwrapped, in the box), and a really neat custom control that I found, and...

In the end, I plumped for **Inmark's zApp Application Framework**, which I co-reviewed with Dan O'Brien last month. Of all the C++ encapsulations of Windows in all the bars in all the world, we both felt this was the best attempt we had seen, and was something of a landmark in the use of this important language. So congrats to Inmark and Microsoft and Borland, and comizes to everyone else.

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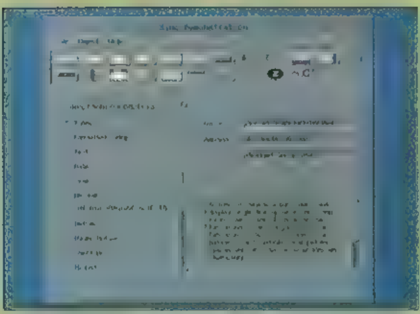
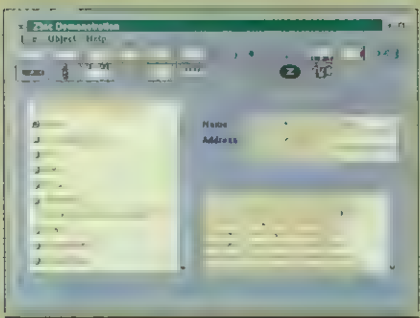
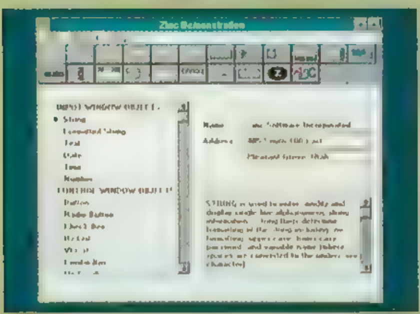


UNIX MOTIF



OS / 2 2.0



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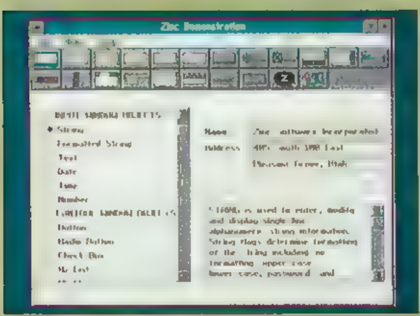

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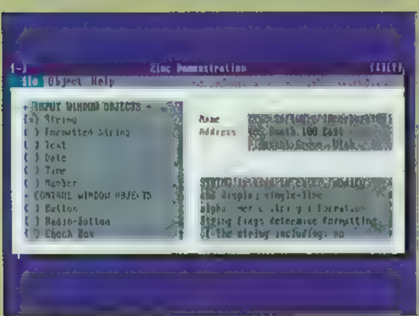

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➤ CIRCLE NO. 899

Text into Fax does go

In the first of a major new .EXE series, Andrew Margolis explains some basics of facsimile technology, and details how to convert text to a faxable format.

It is now becoming standard for even inexpensive modems to include both send and receive Group 3 fax facilities as part of their standard capabilities. Unfortunately, while most people are relatively happy with the programming file transfers and normal data communications, the way that fax transmissions work and the details of how to write your own fax software remain rather more of a closed book. This is due both to lack of information and also to the fact that developing techniques for encoding, decoding, transmitting and receiving faxes presents specific programming problems of their own. Modem manuals don't help much in sorting out any of these problems.

The result of this is that most people are restricted to using the fax software that comes free with their modem, which is something of a shame, as free software is often not going to do what you want in the way you want to do it. The purpose of this article, and subsequent ones in the series, is to present the basics of how fax software can be constructed. This month we aim to present enough information to enable you to turn an ordinary ASCII text file into a fax image file on disk ready for sending.

The bible for anyone looking for the specifications for encoding Group 3 fax messages is the standard laid out in CCITT Recommendation T.4. which is over 30 pages long. While the information contained in this article hits the high spots and is intended to be sufficient for anyone who is writing software for himself, it might make sense for really serious commercial users to look up the original. The recommendation is designed for sending A4 pages, though it includes options for larger and smaller page sizes which won't be dealt with here.

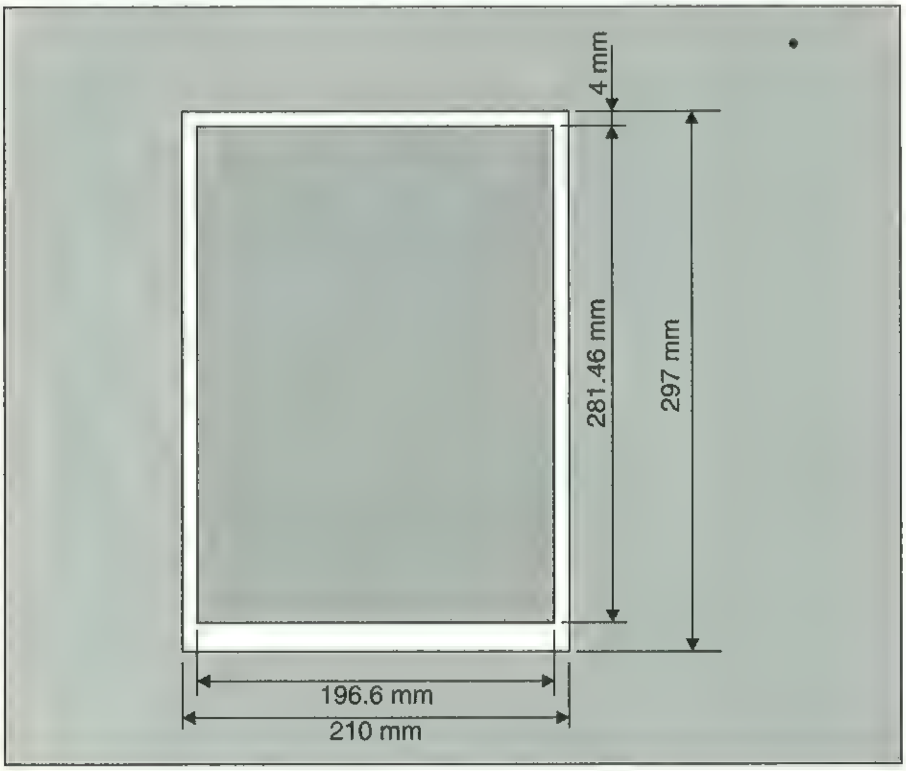

Figure 1 -
Guaranteed reproducible area of T.4 fax recommendation

Basic Fax Facts

The horizontal resolution of a fax is specified as being 1728 picture elements (known as 'pels' to the CCITT, and as 'dots' or 'pixels' to everyone else) on a 215mm line. This works out at 8.04 pels/mm. The vertical resolution is normally 3.85 lines/mm. There is an allowable deviation of ± 1%, which means that the resolution of transmitted or reproduced pictures could range from 7.96 x 3.81 to 8.12 x 3.89.

There is an optional fine resolution of 7.7 lines/mm, which is double that of normal resolution. This needs pointing out as most fax machines and fax modems support it, but since it requires only trivial modifications to techniques for generating and decoding normal resolution faxes, it won't be mentioned again.

A number of things about the T.4 specification are easy to miss. The most commonly overlooked pitfall is that though the specification is designed for sending A4 pages, it doesn't itself conform to A4 dimensions. In particular, the T.4 horizontal resolution is based on a 215 mm line which is clearly a rounded figure designed to accommodate US and old Imperial 8.5 inch wide paper sizes as well as official 210 mm wide A4 paper. This means that while a fax line always consists of 1728 pels, an A4 line when faxed consists of 1688 pels. Of course, if you ignore the difference and encode all A4 lines to the full 1728 pels, the resulting fax file will be perfectly legal and will still be sent, but the margin of

TERMINATING CODES

run	white code	black code
0	00110101	0000110111
1	000111	010
2	0111	11
3	1000	10
4	1011	011
5	1100	0011
6	1110	0010
7	1111	00011
8	10011	000101
9	10100	000100
10	00111	0000100
11	01000	0000101
12	001000	0000111
13	000011	00000100
14	110100	00000111
15	110101	000011000
16	101010	0000010111
17	101011	0000011000
18	0100111	0000001000
19	0001100	00001100111
20	0001000	00001101000
21	0010111	00001101100
22	0000011	00000110111
23	0000100	00000101000
24	0101000	00000010111
25	0101011	00000011000
26	0010011	000011001010
27	0100100	000011001011
28	0011000	000011001100
29	00000010	000011001101
30	00000011	000001101000
31	00011010	000001101001
32	00011011	000001101010
33	00010010	000001101011
34	00010011	000011010010
35	00010100	000011010011
36	00010101	000011010100
37	00010110	000011010101
38	00010111	000011010110
39	00101000	000011010111
40	00101001	000001101100
41	00101010	000001101101
42	00101011	000011011010
43	00101100	000011011011
44	00101101	000001010100
45	00000100	000001010101
46	00000101	000001010110
47	00001010	000001010111
48	00001011	000001100100
49	01010010	000001100101
50	01010011	000001010010
51	01010100	000001010011
52	01010101	000000100100
53	00100100	000000110111
54	00100101	000000111000
55	01011000	000000100111
56	01011001	000000101000
57	01011010	000001011000
58	01011011	000001011001
59	01001010	000000101011
60	01001011	000000101100
61	00110010	000001011010
62	00110011	000001100110
63	00110100	000001100111

Figure 2a - Terminating run length codes.

error on the resulting images will be rather more than the permissible 1%. Further, keeping a 3.85 lines/mm vertical resolution while ignoring the difference between fax and A4 dimensions will result in reproduction errors such as circles on originals being stretched out to ellipses at the destination, and horizontal scales on faxed maps becoming inaccurate for estimating vertical distances.

Another commonly overlooked feature of the T4 specification is that it includes a number of allowances designed to ensure that faxes are properly encoded and reproduced by mechanical scanners and printers. These include at least 4 mm unreproducible space at the top of a fax to allow for paper insertion loss, and ±6.8 mm further loss at the bottom of a fax to allow for paper skew, gripping loss and scan line tolerance. Horizontally, a further error of ± 13.4 mm on both the margins needs to be allowed for also. The CCITT therefore publishes a diagram of the guaranteed reproducible area of an A4 page, a version of which is itself reproduced in Figure 1. You'll see that when everything is taken into account, only the middle 196.6 mm of an A4 page is guaranteed to be faxable. This means that the number of pels allowed for one line from a source file comes down to 1580, with a compulsory white space margin of 74 pels on both the left and right hand sides of the paper.

T.4 encoding rules

The rules for encoding a fax are quite straightforward. We quote directly from the CCITT T.4 documentation, which is unambiguous and reasonably concise:

'A line of Data is composed of a series of variable length code words. Each code word represents a run length of either all white or all black. White runs and black runs alternate. A total of 1728 picture elements represents one horizontal scan line of 215 mm length.

'In order to ensure that the receiver maintains colour synchronisation, all Data lines will begin with a white run length code word. If the actual scan line begins with a black run, a white run length of zero will be sent. Black or white run lengths, up to a maximum length of one scan line (1728 picture elements or pels) are defined by the code words .... *(reproduced here in Figure 2)* .... The code words are of two types : Terminating code words and Make-up code words. Each run length is represented by either one Terminating code word or one Make-up code word followed by a Terminating code word.

'Run lengths in the range of 0 to 63 pels are encoded with their appropriate Terminating code word. Note that there is a different list of code words for black and white run lengths. Run lengths in the range of 64 to 1728 pels are encoded first by the Make-up code word representing the run length which is equal to or shorter than that required. This is then followed by the Terminating code word representing the difference between the required run length and the run length represented by the Make-up code.

'End-of-line (EOL): This code word follows each line of Data. It is a unique code word that can never be found within a valid line of Data: therefore, resynchronisation after an error burst is possible. In addition, this signal will occur prior to the first Data line of a

MAKE-UP CODES

run	white code	black code
64	11011	0000001111
128	10010	000011001000
192	010111	000011001001
256	0110111	000001011011
320	00110110	000000110011
384	00110111	000000110100
448	01100100	000000110101
512	01100101	0000001101100
576	01101000	0000001101101
640	01100111	0000001001010
704	011001100	0000001001011
768	011001101	0000001001100
832	011010010	0000001001101
896	011010011	0000001110010
960	011010100	0000001110011
1024	011010101	0000001110100
1088	011010110	0000001110101
1152	011010111	0000001110110
1216	011011000	0000001110111
1280	011011001	0000001010010
1344	011011010	0000001010011
1408	011011011	0000001010100
1472	010011000	0000001010101
1536	010011001	0000001011010
1600	010011010	0000001011011
1664	011000	0000001100100
1728	010011011	0000001100101
EOL code word		000000000001

Figure 2b - Make-up run length codes.

```
getfont:
        push    es
        push    si
        mov     ax,1130h ; video function 11h subfunction 30h
        mov     bh,6     ; with bh=6
        int     10h      ; returns font pointer in es:bx
        push    es
        push    ds
        pop     es
        pop     ds
        mov     si,bp             ; font pointer now in ds:si
        mov     di,offset fonts   ; our array pointed at with
                                  ; es:di
        mov     cx,256*16/2       ; length of font table in words
        rep     movsw             ; now copy it into our array
        pop     si
        pop     es
```

Figure 3 - Downloading the VGA 8 x 16 font

page .... the end of a document transmission is indicated by sending six consecutive EOLs.'

Digitising text

We've now established both the physical parameters of a fax image and the format it takes. It is quite a good idea to convert a text file into a fax file one line at a time. The advantage of this is that text files of any length can be converted without running any risk of running out of memory space, as we can work out exactly what the maximum requirements of any line might be. Without attempting to give the code for a complete program, the rest of this article will concentrate on the trickier points involved in turning text into a fax. The code fragments are fairly standard C, and are intended simply for illustration. They ought to translate into other languages and dialects fairly easily as the only capabilities that are really required are the ability to do both arithmetic and simple boolean algebra (ANDs and ORs) on unsigned 8 and 16 bit values and the ability to construct and access indexed arrays.

The first step we take is to reduce a single line of text to a series of dots. This digitisation process is actually quite straightforward once you have a font table of the correct size. Determining the size of the font may on the surface appear to be mostly a matter of personal taste - a smaller font allows more lines on a page and more characters on a line, but runs the risk of illegibility due to transmission errors if sent over bad telephone lines, while an over-large font might not allow a normal page to be sent.

However, another factor that affects the choice of a font is how easy it is to structure the data in memory. It's obvious that a font which is eight bits wide will fit neatly into a straightforward array, while a font that is nine bits wide isn't quite as easy or quick to access and manipulate. It might make apparent sense to choose a byte-wide font for just this reason, but unfortunately, if such a font is used on an A4 fax line we'd get almost 25 characters to each inch. Obviously, when compared to a normal line of A4 text, each letter will be rather too small. This is actually quite a serious problem, as small letters are much more prone to become illegible through printing and transmission error.

Using a Font Table

A solution to this problem which keeps the convenience of programming for an 8-bit font, and also reproduces text to a scale approximating that of a printer, is simply to adapt an 8 x 16 text font by scaling it up to 20 x 16. The base font vertical dimension of 16 dots already translates directly to a little over six lines per inch (assuming the standard 3.85pels/mm and 281mm reproducible A4 length). For the horizontal dimension we can add a dot for an inter-character gap on each side, giving us a width of 10 dots, and then double up the width to 20 dots per character. This allows 79 characters on our 1580 pel faxed A4 page. Using a 20 x 16 font corresponds quite well to the format of a printed page on a standard printer of 80 characters per line and six lines per inch.

The deciding factor in choosing an 8 x 16 font for your first fax program is that anyone with an IBM PC and a VGA card can download the font into a simple two-dimensional array of 256 characters by 16 rows with each row of eight dots directly represented by one byte. This will be suitable for almost immediate use. Assembler code for downloading such a font is shown in Figure 3 - it will embed in many PC dialects of C for inline assembly and subsequent run-time downloading.

Once you have a font, the simplest method of digitising a line of text is to loop through the line once for each vertical row. The value of each character in the line and the value of the row as taken from the variable controlling the loop become direct indices to a 16-byte wide font array. The code for doing this (in Figure 4) is surprisingly compact, consisting of two nested `for` loops (though in practice, you might want to expand tabs rather than ignore all control characters). The moral to be drawn here is that if you get the data structure right, the hard work goes out of the programming.

Each of the 16 rows of dots generated for each line of text has to end with a unique sentinel (`EOLFLAG`), which can be any configuration of bits not occurring in the font data. A good choice if using a VGA font is `0x01`. This is because we don't know in advance how many characters there actually are in a line of text. When we come to encoding the fax, if we hit an `EOLFLAG` in the bit image, we simply pad out the rest of the line to 1728 pels.

```
fgets (line_of_text,80,input_file)
for (row=0 ; row<16 ; row++)
{
  for (i=0 ; i<strlen(line_of_text) ; i++)
    if (line_of_text[i]>31)
      bit_image[image_offset++] =
          fonts[line_of_text[i]][row] ;
  bit_image[image_offset++]=EOLFLAG ;
}
```

Figure 4 - Digitising a line of text

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Finally, Don leaned back and asked the assumptive question, "What about protection – are you using Sentinel?"

Nervously, Simon sipped his coffee. His hands shaking as his eyes darted the room. "No. I didn't think I needed to."

Don's chair slid out from under him and he crashed to the floor. Amazed in disbelief, Don cried, "You What?!" Grabbing his tattered scrapbook, Don pulled out photos of his travels. "Ever been to Seoul? Prague? Anywhere? Ten bucks will buy you anything, even bootlegged copies of software."

Don's Road to Success

Thumbing through the scrapbook, Don shared his experiences. "Back in the '80s, I was in your shoes – beaten, battered and bruised." Simon listened. "Then, after a heart breaking trip around the world, I called the Software Publishers Association (SPA)."

"I could hardly believe it. They told me developers lose billions of dollars each year. Why? Illegally copied software. In some countries there are nine pirated copies for each legal copy sold."

Simon was disgusted, "It's just not fair."

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➤ CIRCLE NO. 900

```
for (c=0x80 ; c ; c>>=1)
{
  if ((colour&c)==(octet&c))
    run_length++ ;
  else
    colour ?
       nextwhite () :nextblack () ;
}
```

Figure 5 - Dismantling octets of eight bits and calculating run lengths

Encoding the bit image

Once you've digitised your line of text, the real fun begins. On the surface, the T.4 specification ought to make turning lines of dots into encoded lines of fax data quite simple. However, the point about the codes in Figure 2 is that they aren't binary values, but sequences of bits. They don't fit neatly into bytes, as they have variable lengths, and they can't be padded out to bytes at either end as that would falsify the coding. For example, a white run of two is 0111 and if padded out with leading zeros it turns into a black run of 14, which is 00000111. If padded out with trailing zeros, the code following would be invalidated - a black run length of four (011) would become 0000011, which is the code for a run length of 22.

This may seem to be a total pain in the neck, but there's a fair amount of logic in the way the system works. Variable length codes chosen on the basis that the most frequent occurrences should have the shortest lengths really does shorten transmission times substantially, as Samuel Morse demonstrated practically about the time that Babbage was trying rather less practically to get his differential engine working. If you think about the way that text appears on a sheet of paper, you begin to realise that short run lengths of black are generally interspersed with slightly longer run lengths of white, with long black runs being very uncommon compared to long white runs. The codes chosen are optimised for sending printed (black on white) text in the shortest time.

What we need to do is discard the idea of each byte of bit-image data being meaningful and instead to treat bytes as octets of eight individually meaningful bits which only happen to be grouped in eights for convenience. After all, while we are trained as programmers to think in a 'byte-ist' manner, this isn't necessarily the only way to organise information. It is unfortunate that most of the programming tools we work with incorporate similar byte-ist assumptions, and the higher level the language, the more difficult it is to encode and decode fax data.

Back to the task in hand. We've turned a single line of text into a bit image containing 16 rows of dots, which all end with a unique sentinel. We have to encode each of these sixteen rows into the correct fax form, which means that we need to identify and count consecutive sequences of 0 bits (white runs) and 1 bits (black runs) in each rows. We need keep track of both the colour of the run we are counting and the number of bits we have counted in the current run length. The principle is that we look at each bit in turn: if it matches the colour of the current run we increment the count, but if it's a different colour we need to end the last run (encoding the count for the last colour) and start a new run with the other colour.

Getting at the bits in a byte is a doddle in virtually any assembler - just rotate a byte to the left eight times and look at the carry flag to find out the colour. While no high-level languages in common use give you access to a carry flag, there are a number of ways of tackling the problem which don't require one. The traditional method is via eight logical ANDs, which is easily done in most languages. This could be coded either iteratively, simply for ANDing a byte successively with 128, 64, 32, 16, 8, 4, 2, and 1, or else as a loop, by using an 8-bit unsigned integer initialised to 128 and either shifting right one bit or else dividing by two until the result is 0. The loop would of course execute slightly slower, but is used in the fragment in Figure 5 as it is more convenient for illustration. It's important to note that using this method, the variable `colour` **must** contain either `0xff` for black or `0x00` for white - look up a text on boolean algebra if you aren't sure why this is necessary or how it works.

Encoding Run Lengths

Figure 5 uses two complementary functions, `nextwhite()` and `nextblack()`, to handle the case where we have ended one run length and begun another. We can obtain the code for the run length we have just finished by keeping the codes in an array and using the run length to derive an index into the correct table. If the run length is greater than 63, we do the necessary arithmetic to get hold of the make-up code followed by the remaining terminating code. The code fragment in Figure 6 illustrates this being done with a black run length, which of course would be part of the `nextwhite()` function.

```
if (run_length>63)
{
  shiftin (&blackmakeup[(run_length/64)-1]) ;
  run_length%=64 ;
}
shiftin (&blackrun[run_length]) ;
```

Figure 6 - Using run lengths as indices to fax codes arrays

That's all quite straightforward: what isn't quite so obvious is the best way of storing all the codes from Figure 2 in the data section of the program. The problem is the same one we encountered when encoding, as we have to avoid values such as black runs of two (11), of four (011), of five (0011) and of seven (00011) as well as the code for a white run of 13 (000011) being stored as identical values.

Of the different ways of overcoming this problem, the most straightforward to use and quickest to execute is to store the set of codes as four arrays consisting of the count of bits in the code followed by the code itself padded out at the least significant end. A two-dimensional integer array would work quite well, but a more efficient way in C is to store the data as a simple structure array. The structure declaration would look like this:

```
struct huffdef
{
  unsigned char count;
  unsigned short int values;
} ;
```

and a code such as the one for a white run of 3, which has bit sequence '1000', would be stored in the form `4,0x8000`. As we'll see, it's worth padding out on the right - once again, getting the data organised correctly makes the code easier to write.

```
for ( ; bit_count ; bit_count--)
{
  if (padded_code&0x8000)
    fax_file[current_byte]|=1 ;
  else
    fax_file[current_byte]&=0xfe
;
  padded_code<<=1 ;
  if (!(--spare_bits))
  {
    ++current_byte ;
    spare_bits=8 ;
  }
  else
    fax_file[current_byte]<<=1 ;
}
```

Figure 7 - Shifting variable length bit codes into bytes

Creating the file

The lowest level part of the code takes the address of the correct element of the code array as a parameter. Its sole job is shifting the right number of bits into the fax in the right order. While this is the trickiest part of the whole process to code in any byte-oriented language, it is made much simpler when we have access to the number of bits in the code we want, and the code itself is held in a 16-bit word padded out at the right. All we need to do is to loop for the number of bits in the code `bit_count`, shifting one bit at a time out of the left of the right padded code word and into the right of the current byte of the fax file we are encoding. A static variable (`spare_bits`) keeps track of the number of bits we have available in the current byte. A suitable code fragment is listed in Figure 7. It checks the high bit of the code word by ANDing it with `0x8000` and uses the result to set the low bit of the current byte to either 1 by ORing it with 1, or to 0 by ANDing it with `0xfe`.

It is probably a good idea to make sure that, if an EOL code is being shifted in, it ends on a byte boundary. This enables encoded lines to be written out to the fax file on disk as they are generated. The T.4 specification makes this easy, as any number of fill bits (value 0) can precede an EOL code.

All the rest of the code needed to write a program to generate fax images from text files should be quite straightforward. Next month we move on to decoding, sending and receiving fax data.

(To be continued...)

EXE

Andrew Margolis runs a software house and consultancy specialising in communications, emulations, fax, EPOS and utilities for a wide range of systems. He can be contacted at Margolis & Co on 081 889 7755.

If you don't feel like writing fax handling code yourself, Andrew has made the (Borland and Microsoft C) binaries of his fax software available on a shareware basis. Registration, which costs £30 ('A real bargain!' - A Margolis), buys you the full C and assembler source for encoding, decoding, sending and receiving faxes. For a free copy of the object code, please see the `dotexe/files` *topic on CIX, or send us a disk and SAE, following the instructions given in column 1 of the Contents Page. Please mark your envelopes 'FAX'. To register and obtain the source, please contact Andrew directly..*

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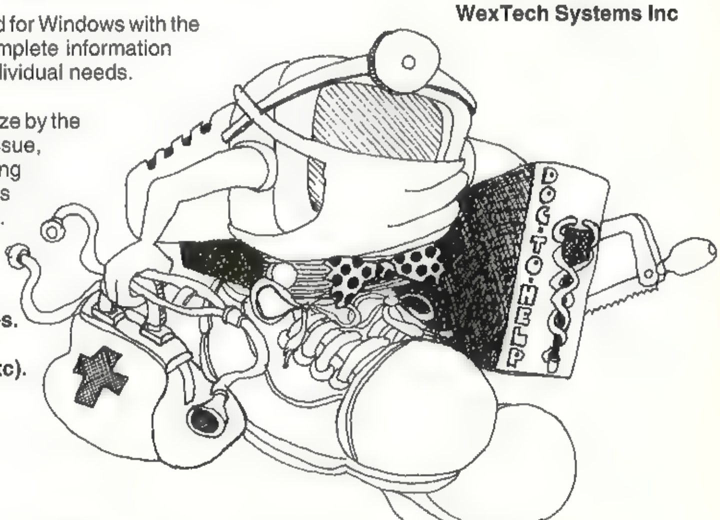

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DTHAD2

➤ CIRCLE NO. 947

Abstract Syntax Notation One

Chris Adie presents a mechanism for sending and receiving complex data structures in a machine-independent manner.

Have you ever had to transfer binary data between computers with different architectures? Apart from the actual mechanism of communicating the data, the most important problem is that of data representation. Ideally, you need to be able to transmit an arbitrarily complex data structure in a machine-independant format, without concern for issues such as word size, byte order, or structure alignment.

The Open Systems Interconnection (OSI) seven-layer protocol suite deals with the question of data representation at layer 6, the Presentation layer. It defines a language called ASN.1 (Abstract Syntax Notation One) which is explicitly designed to make it easier to transfer data between dissimilar computer systems. In fact, ASN.1 is not just a part of the OSI Presentation layer - it is used by all Application layer (layer 7) protocols such as X.400 (electronic mail) and FTAM (file transfer). Increasingly, it is finding uses outside OSI too.

ASN.1 is not a programming language in the way that C or Pascal is - it does not consist of executable statements and you can't speak of 'an ASN.1 program'. Instead, it is concerned with defining data types and how values of these types are represented as a stream of bytes which can be transferred between two systems. We will start off by examining ASN.1's Basic Encoding Rules, which specify how an arbitrary data structure can be represented as a byte stream.

Basic Encoding Rules

Let's see how we might represent an array of integers in such a byte stream. For a single integer, the most compact representation is just the two's complement binary form, so 100 decimal is represented just by:

```
64
```

(we'll use hex for byte streams). For integers greater than 127 and less than -128 we need more than one byte. The question is: do we output the least significant, or the most significant byte first (ie little-endian or big-endian)? There is no compromise which is independent of processor architecture, so we'll arbitrarily choose to output the most significant byte first. 513 decimal is therefore represented as:

```
02 01
```

When we have an array of such integers, we need some way to specify where one integer value ends and another begins. So, let's prefix each integer by a byte indicating the number of bytes required to stored it. The three element array 63, -1, 258 would then look like:

```
01 3F 01 FF 02 01 02
```

Now, for reasons that will become apparent later, we're going to precede each length byte with an `02` identifier byte, to signify that the type of the data to follow is integer. So for our three-element array, the byte stream looks like:

```
02 01 3F 02 01 FF 02 02
01 02
```

In order to indicate that these three integers form an array, we'll preceed them with an array identifier byte (`30`) and a length byte (`0A`). So the final byte stream encoding for the three integer array 63, -1, 258 is:

```
30 0A 02 01 3F 02 01 FF
02 02 01 02
```

We could create a file containing these twelve bytes or we could transmit them on a network. The system which read the file or received the bytes from the network would be able to decode them without having to know anything about the word length or processor architecture of the system which created the byte stream.

What we've developed in the last few paragraphs is the basis of a set of rules for encoding data structures in a processor-independent way. In fact, these Basic Encoding Rules are defined and published by the telecomms regulator CCITT (as recommendation X.209) and also by the International Standards Organisation (as International Standard 8825). The ASN.1 language itself is defined in International Standard 8824 and addenda, and also in CCITT Recommendation X.208.

Every data item encoded according to the Basic Encoding Rules comprises an identifier, followed by a length, followed by the contents of the data and optionally terminated by an 'end of contents' (EOC) marker (see Figure 1). The identifier contains a 'tag' which gives the type of the data item and a flag to indicate whether the data item is 'primitive' (ie the contents bytes are a basic type such as an integer or a real number) or whether it is 'constructed' (ie a C structure where the contents bytes themselves comprise BER-encoded data items). Figure 2 shows how the identifier is made up.

The tag attached to a data item can be one of four classes, as indicated by bits 6 and 7 of the identifier. Universal class tags are used for common data items such as integers, strings, arrays and so

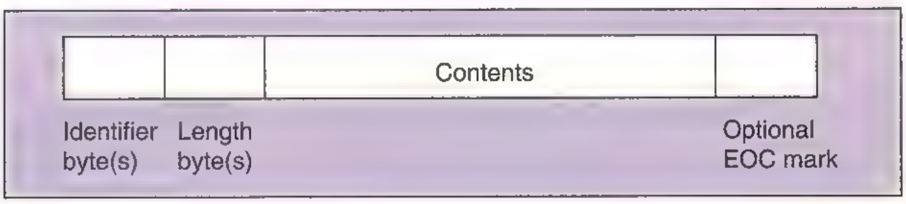

Figure 1 - A data item using the Basic Encoding Rules

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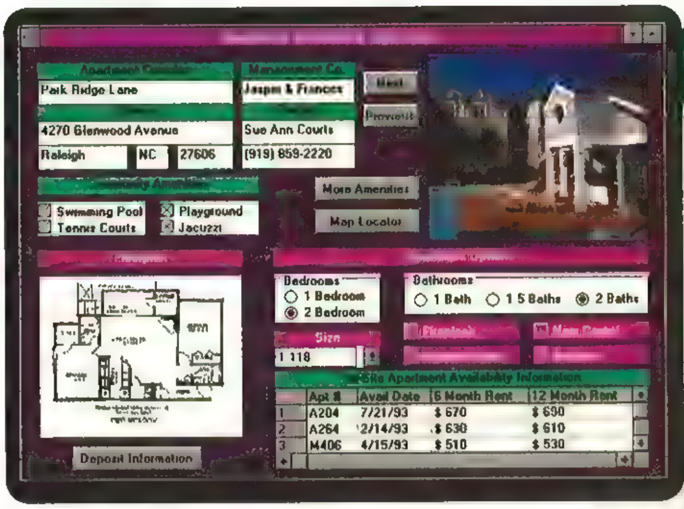

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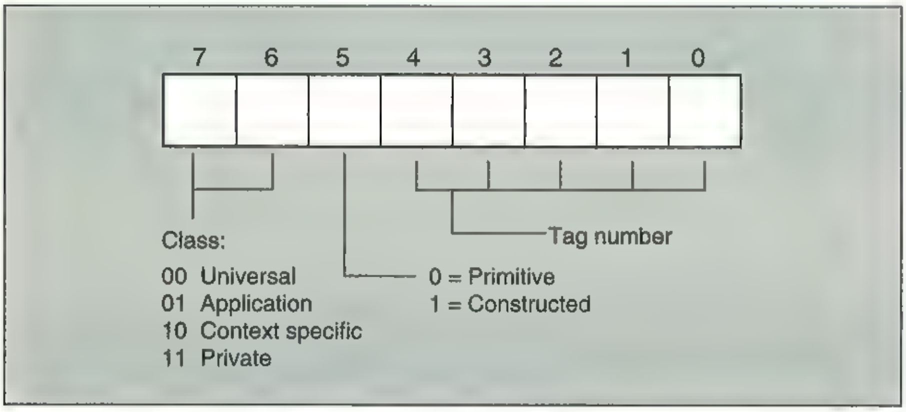

Figure 2 - Structure of the first identifier byte.

forth (see Table 1). Private class tags may be defined by an organisation to indicate organisation-specific data types. For instance a bank might define a private tag to indicate that the enclosed contents represent a sum of money. Application class tags are used within the context of a particular application - ie electronic mail. And Context-specific tags are used to distinguish between otherwise identical types inside a constructed type. We'll see several examples of context-specific tags shortly.

The tag value can be anything from `0` upwards. If it is less than `0x1F`, it is represented in the bottom five bits of the identifier byte. The value `0x1F` indicates that the identifier uses more than one byte - the tag is carried in subsequent identifier bytes.

Type	Tag (hex)	Encoding *
BOOLEAN	01	P
INTEGER	02	P
BIT STRING	03	P/C
OCTET STRING	04	P/C
NULL	05	P
OBJECT IDENTIFIER	06	P
ObjectDescriptor	07	P
EXTERNAL	08	C
REAL	09	P
ENUMERATED	0A	P
SEQUENCE [OF]	10	C
SET [OF]	11	C
NemericString	12	P/C
PrintableString	13	P/C
TeletexString	14	P/C
VideotexString	15	P/C
IA5String	16	P/C
UTCTime	17	P
GeneralizedTime	18	P
GraphicString	19	P/C
VisibleString	1A	P/C
GeneralString	1B	P/C

* P = Primitive Type
C = Constructive Type

Table 1 - Built-in ASN.1 types

The length bytes also have an internal structure. In fact, for constructed types, a method of encoding can be used in which the length is simply the single byte `80`: the contents are delimited by the end-of-contents marker, made up from two consecutive `00` bytes. This is called 'indefinite encoding' and is used when you don't know the length of the encoded data before it is transmitted. The other method, 'definite encoding', takes two alternative forms. The first of these can be used when the length of the contents is 127 bytes or less - ie the length can be represented by a single byte. The second form is used for greater lengths. Here the first length byte has the top bit set, and the remaining 7 bits indicate the number of subsequent bytes which comprise the actual length of the contents. For instance, two possibly encodings of the integer 7 are:

```
02 01 07
```

or equivalently:

```
02 84 00 00 00 01 07
```

In the second form, four bytes are used to represent the length, preceded by one 'length of the length' byte. Note that both these encodings are fixed length, since integers are primitive types. But indefinite length encoding can be used with constructed types such as arrays:

```
30 80 02 01 07 00 00
```

This is an array containing a single integer, value 7. The array is encoded in indefinite length form. (Note that the end-of-contents marker is actually a primitive type with a tag of 0 and a length of 0.)

Data Types

In order to describe the complex data structures which we are now able to encode and decode we need some kind of data description notation. We could simply use C `typedefs` or Pascal `records` - but these have no natural way for representing tags. Also, certain data types (such as C arrays) can be specified in more than one way, obscuring the data description.

ASN.1 lets you specify data types of arbitrary complexity which map onto the Basic Encoding Rules in a very natural way. Figure 3 shows some simple ASN.1 type definitions, together with equivalent C `typedef` statements. Three types are defined: `Currency` is an enumerated type; `Amount` is a `SEQUENCE` (equivalent to a C `struct`) containing two components - `currency` (of type `Currency`) and `sum` (of type `INTEGER`) and `Amounts` is an array of `Amount` (arrays are denoted by `SEQUENCE OF` in ASN.1). Note that types in ASN.1 start with a capital letter while component names start with a lower case letter. Figure 4 illustrates the encoding of `Amounts`.

ASN.1 data types

```
Currency ::= ENUMERATED {
  pounds (0),
  us-dollars (1),
  german-marks (2),
  yen (4)
}

Amount ::= SEQUENCE {
  currency Currency,
  sum INTEGER
}

Amounts ::= SEQUENCE OF Amount
```

C equivalents:

```
typedef enum {
  pounds=0,
  us_dollars,
  german_marks,
  yen=4
}
Currency;

typedef struct _Amount {
  Currency currency;
  int sum;
} Amount;

typedef Amount Amounts[80];
/* NB: C, unlike ASN.1, */
/* requires array size  */
```

Figure 3 - Some simple ASN.1 types and their C `typedef` equivalents.

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➤ CIRCLE NO. 903

```
30 80                        SEQUENCE OF
      30 80                  SEQUENCE
            0A 01 00         pounds
            02 02 03 E8      1000
      00 00                  end of SEQUENCE
      30 06                  SEQUENCE (definite length)
            0A 01 02         german-marks
            02 01 C8         200
00 00                        end of SEQUENCE OF
```

(Byte stream is shown broken up and indented for ease of interpretation)

Figure 4 - Encoding for £1000 and DM200 Amounts

The tag for SEQUENCE and SEQUENCE OF are the same - this reflects the fact that in C (or any other programming language) an an array can be treated as a struct with a number of identical fields. Also notice that we can mix definite and indefinite encoding - the first Amount is encoded with indefinite length, the second with definite length encoding.

As well as SEQUENCE and SEQUENCE OF, we can use SET and SET OF. The difference is that in a SEQUENCE the order of the components is significant, whereas in a SET they may be encoded in any order. For instance, if we had defined Amount as a SET, then we could have encoded £1000 as:

```
31 80 02 02 03 E8 0A 01
00 00 00
```

Figure 5 is a complete ASN.1 module which illustrates some more features of the language. A module starts with the module name, followed by the symbols DEFINITIONS ::= then a BEGIN/END block which contains the body of the module. In order to reference types defined in some other module, we use the IMPORT statement to make it available. Similarly, to make a type defined in this module available to other modules we name it in an EXPORTS statement.

The module SomeBankingTypes defines just one type - AccountBalanceReport (intended to represent a message which might be sent by a central bank computer) which is a SEQUENCE containing a number of components. The first component, bank-sorting-code, is marked with the keyword OPTIONAL, indicating its possible absence from a particular value of this type. It is of type VisibleString, which is essentially the ASCII character set. (ASN.1 has a number of character string types built in - they are mostly subsets or extensions of ASCII.)

The [0] in the definition of the bank-sorting-code component indicates that this component is encoded with a context-specific tag of 0. By default, this is in addition to the Universal class tag associated with the VisibleString. The purpose of tagging components in this way is to make it absolutely clear which component is which - very necessary if the SEQUENCE contains a number of identical types, some of which are optional.

The next component, account-id, is a CHOICE between two alternatives. The meaning is obvious - one and only one of the types in a CHOICE may be present in a particular value (ie a C union). The CHOICE does not have a tag of its own. Clearly, the tags of the individual choices must be distinct, to avoid ambiguity in an encoded value.

Let's look at a particular value of AccountBalanceReport, encoded in a byte stream. Figure 6 shows how the byte stream is made up. Notice how we can choose either definite or indefinite length when encoding context-specific tags. It is only the innermost (primitive) data which must use definite length encoding.

Compilers

So, now we have a powerful notation for defining data types and an unambiguous and machine-independent way to represent values of these types as a byte stream. What we now need is a way to translate the ASN.1 types into C structs (or Pascal records) and a means of automatically encoding and decoding a bytestream. This is the role of an ASN.1 compiler.

ASN.1 compilers are available from several different suppliers, but they all work in slightly different ways. One of the most popular is the compiler from Open Systems Solutions (Princeton, New Jersey), which targets the C language. The input to the compiler is one or more ASN.1 modules. Output consists of a C header file containing typedefs and #defines which correspond to the ASN.1 types and a table (in the form of a statically initialised array) which is used for encoding and decoding the byte stream.

Writing the application involves #including the compiler-generated header file; setting up the required structs in memory and calling the OSS encoder (supplied in a linkable library with the compiler) to create the byte stream. The encode routine uses the table produced by the compiler to construct the byte stream. Similarly, there is a decode routine which converts a byte stream into C structures.

The OSS compiler offers a great deal of control over the type of C structures which are generated.

```
SomeBankingTypes  DEFINITIONS ::= BEGIN

IMPORTS Currency FROM SomeOtherModule
EXPORTS AccountBalanceReport

AccountBalanceReport ::= SEQUENCE {
  bank-sorting-code [0] VisibleString OPTIONAL,
  account-id CHOICE {
    account-name [1] VisibleString,
    account-number [2] NumericString
  }
  balance [3] Amount
}
END
```

Figure 5 - A complete ASN.1 module

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```
30 80                                        SEQUENCE
      A0 0A                                  [0]
        1A 08 38 30 2D 33 31 2D 32 35        VisibleString "80-31-25"
      A1 80                                  [1]
        1A 07 4A 2E 53 6D 69 74 68           VisibleString "J.Smith"
      00 00                                  end of [1]
      A3 0B                                  [3]
        30 80                                SEQUENCE
          0A 01 00                           ENUMERATED pounds(0)
          02 02 03 E8                        INTEGER 1000
        00 00                                end of SEQUENCE
00 00                                        end of SEQUENCE
```

(Encoded value of type `AccountBalanceReport`: £1000 in account called J.Smith at branch 80-31-25).

Figure 6 - Definite- and indefinite-length encoding.

Identifiers and Syntax

One of the built-in types in ASN.1, with a Universal class tag of 6, is the `OBJECT IDENTIFIER` type. An object identifier is simply a finite series of integers, with the first in the series restricted to 0, 1 or 2 and the second restricted to the range 0-39 inclusive with any non-negative integer possible subsequently. Conventionally, they are written in curly brackets, or else with full stops between them, thus:

`{2 3 6 1 10}`

or:

`2.3.6.1.10`

Object identifiers are used as names for various ASN.1 constructs - ie source modules can have their own object identifiers. The thing that makes them so useful is that they form a single, unified, infinite name space with a hierarchical structure which facilitates distributed naming. Object identifiers which start with `0` are allocated by CCITT, those starting with `1` are allocated by ISO, while those starting with `2` are allocated by ISO and CCITT jointly.

ISO and CCITT then allocate the next integer in the object identifier for various purposes - eg ISO allocates `0` to represent its international standards, so that `1.0.8824` is the object identifier for International Standard 8824. Both ISO and CCITT offer a way for organisations to obtain an object identifier, which they can then use as the basis of a naming tree.

One of the objects which are named using identifiers is an 'Abstract Syntax'. This is simply a collection of related ASN.1 type definitions in one or more modules. (Hence the name Abstract Syntax Notation - but note that the '1' in ASN.1 has no semantic content: it simply reflects a penchant for numbering things!) Syntax in ASN.1 is 'abstract' in the sense that it conveys nothing about how the data is represented inside a particular computer. A 'Concrete Syntax', on the other hand, is a corresponding collection of data structures, in assembler, C, or some other language, which is a more direct representation of the data in terms of a particular computer architecture.

There is a third type of syntax - a 'Transfer Syntax'. Since there's no reason why the Basic Encoding Rules which we have been discussing should be the only way of representing data values in a byte stream, other sets of encoding rules with different properties are available. So one set of encoding rules may incorporate encryption, for instance, while another sacrifices compactness for ease of use. A set of encoding rules is called a Transfer Syntax, and has its own object identifier. The object identifier for the Basic Encoding Rules is 2.1.1.

It is essential that if two systems are using ASN.1 to communicate, they should agree on the abstract syntax and the transfer syntax in use. If the communication is via a file which is written on one system and read on another, prior agreement on the syntaxes is necessary. But if the communication is real time (ie using a network), syntaxes can be negotiated by sending the corresponding object identifiers between the systems before data exchange proper starts. The pairing of an abstract syntax and a transfer syntax is known as a 'presentation context'. The OSI Presentation layer protocol's main function is to figure out what presentation context to use.

Conclusion

Although ASN.1 is very good at its job of providing a machine-independant syntax for exchanging data, like most languages it is not so hot at representing the semantics of data types. Because of this, it can be difficult to make sense of ASN.1 modules in the absence of accompanying comments or explanatory text.

ASN.1 is popping up all over the place. The TCP/IP-based Simple Network Management Protocol (which is certainly not OSI) uses ASN.1 extensively, as does the Kerberos security protocol. ASN.1 is also used in the Open Document Interchange Format (ODIF) and for multimedia/hypermedia data, including digital video. If you have a requirement to exchange data between dissimilar computers, either across a network or using a file-based mechanism, you should certainly consider whether ASN.1 fits the bill.

Further Reading

1. *A Tutorial on ASN.1, Phillip Gaudette, May 1989. Available free of charge by writing to National Computer Systems Laboratory, NIST, Gaithersburg, MD20899, USA, and asking for Technical Report NCSL/SNA - 89/12.*
2. *Specification of Abstract Syntax Notation One (ASN.1). CCITT Recommendation X.208, 1988.*
3. *Specification of Basic Encoding Rules for ASN.1. CCITT Recommendation X.209, 1988.*
4. *ISO. Information Processing - Open Systems Interconnection - Specification of Abstract Syntax Notation One (ASN.1). ISO International Standard 8824, 1987.*
5. *ISO. Information Processing - Open Systems Interconnection - Specification of Basic Encoding Rules for ASN.1. ISO International Standard 8825, 1987.*
6. *OSS ASN.1 Tools Reference Manual. Open Systems Solutions Inc, 1992.*

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CCITT recommendations and ISO standards are available from Omnicom Ltd (0438 742424). Open Systems Solutions can be contacted on 0101 609 987 9073.

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VOLUME 15 Ref: ED153

MULTIP
Here is an example program which illustrates the power of the Microsoft Foundation Classes (MFC). The program is a fully working programmer's editor with multiple windows, Print & Printer Setup dialog boxes and a Cut & Paste facility. Other features include Search & Replace, Find Next/Previous and Tile/Cascade for rearranging windows. With over 55 KB of source, MULTIP provides a thorough foundation for building your own MFC applications, especially MDI apps. (Public Domain)

PREVIEW
It is often necessary to determine which fonts are available to the system. PREVIEW is a 500-line TPW program which will show you how to do this using OWL. The code provides plenty of examples on font manipulation, and is an ideal starting point for writing applications such as Windows text editors. (Public Domain)

ULTRACLIP
The problem with the Windows 3.1 clipboard is that it only lets the user copy one object at a time. ULTRACLIP is a utility which allows you to store as many objects on the clipboard as your system memory will allow. Each time an object is copied to the clipboard, ULTRACLIP creates a new window and copies the object into it. Full TPW source is included. (Shareware)

PROFFT
PROFFT is a Public Domain image processing package for Windows which gives remarkable performance using the Fast Fourier Transform (FFT). After a Windows bitmaps (.BMP) has passed through the FFT, PROFFT provides the user with a total of 7 filters for enhancing the image. Including Low pass, High pass, Band pass, Butterworth Low & High pass and a freehand filter. Complete OWL C++ source included. (Public Domain)

MASKED EDIT
Try this. Go into Windows Control Panel and select `'Ports'`, then `'Settings'`. Now type in your name in the `'Baud Rate'` edit field. See the problem? That's a numeric field, yet Windows doesn't stop Snoopy from keying in 'Charlie Brown'. This C++ class for OWL enhances the standard edit field by allowing the developer to specify a `Filter` containing characters which are acceptable as input. MASKED EDIT comes with BC++ project and source files and an example implementation. (Public Domain)

TXT2RTF
Before you can start creating your own Windows Help files, you've first got to buy a wordprocessor like MS Word for Windows which can produce Rich Text Format (RTF). Alternatively, you could use this DOS-based utility to convert a standard ASCII text-file into a RTF file. Special ASCII characters are embedded in the text file in order to specify Help features such as Titles, Keyword, Cross References etc. The text file can also reference bitmaps. TXT2RTF comes with an example project for BC++. (Public Domain)

WIZUNZIP V1.1
WIZUNZIP is a good-looking Windows-based clone of the popular PKUNZIP DOS utility for expanding .ZIP files. It comes with comprehensive context-sensitive Windows Help and over 350 KB C source. (Public Domain)

VISUAL LIB
The Windows 3.1 GDI is rather primitive when compared to the graphics API in Windows NT (when it's finally released). Visual Library for BC++ extends the GDI *now*. It contains powerful curve and surface drawing functions including: Bezier, Hermit Curves, B-Spline, and NURBS curves and surfaces. There are also functions for drawing several types of graphics object such as Polygons, Ellipses, Spheres and Polyhedra. (Shareware)

VOLUME 16 Ref: ED163

DLLMAKER
This is a TPW utility for assembling a set of units into a DLL. It takes a unit's interface section(s), and generates two new files: a 'binderey unit', which repeats all type declarations and implements all procedures as externals in the DLL, and an 'export library', which explicitly exports public procedures and object methods. (Shareware)

EDI THREADS
Threading is the mechanism by which a program can be made to perform several actions simultaneously. Previously threads were linked with high-powered 32-bit operating systems such as Windows NT and OS/2, but EDI THREADS brings multi-threading into the world of Windows 3.x programming. The library is distributed as a DLL with BC++ and TPW interfaces. (Shareware)

HEAP AUDITOR
Failure to free resources is a common headache in Windows programming and is extremely difficult to track down. HEAP AUDITOR is a utility which displays various statistics about the GDI, Global and Local Heaps. By checking the report before and after the program under examination has been run, a developer can determine whether memory leaks have occurred. (Public Domain)

WINDOWS KERMIT
This is a Windows-hosted terminal emulator which enables the user to upload and download files to/from remote servers using the widely available Kermit file transfer protocol. The package includes substantial support for VT100 and VT52 terminals and comes with over 400 KB of C source which can form the basis of a full-blown comms package. (Public Domain)

NNTPW
The Novell NetWare API can easily be invoked from a DOS applications, but it is more difficult to access in Windows. NNTPW is an example program written in TPW from the November '92 issue of *.EXE* which illustrates how it's done. (Public Domain)

OWLBWCC
OWLBWCC is a group of 18 example programs (with full source code) for using Borland custom controls (BWCC) with OWL. The examples include: how to create a basic BWCC dialog box with metal background, group boxes, bumps and dips; how to use a large custom button as a splash screen and how to perform delayed processing. (Public Domain)

IDLE
In the December 1992 issue of *.EXE* Laine Stump described an extremely elegant way to perform background multi-tasking in Windows using a generic class derived from Microsoft Foundation Classes. IDLE contains the code from the article. There's over 200 KB of source, including Laine's MFC code for a thermometer custom control. IDLE is bound to teach you many new tricks. (Public Domain)

XLMATH
This is a DLL which extends Microsoft Excel by providing custom functions including diagonalizing a real symmetric matrix, creating a frequency distribution and curve fitting functions. C source code is included for extending the DLL and the documentation looks into the difficulties with writing DLLs for Excel such as memory issues, Excel's instance handle and Excel data types. (Public Domain)

UNDOCFCT
How can you be sure that the software you're running will be compatible with future releases of Windows? Many commercial Windows applications rely on undocumented Windows API calls. If Microsoft alters these undocumented functions at a later date, such software may not function correctly. UNDOCFCT is a utility which provides an early warning of potential incompatibility by printing all undocumented entry points and external references in a Windows executable. (Shareware)

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➤ CIRCLE NO. 905

Communicating with Workgroups

Windows for Workgroups has already made an impact as a peer-to-peer networking environment. Resource sharing is fine for users, but what is there for the programmer? Robert Seeman investigates.

The growth of networking has had its effect on Windows. Windows for Workgroups has confirmed the trend towards peer-to-peer networking, either supplementing or replacing systems based on file servers.

Network protocol standards are emerging, allowing the developer to build heterogeneous networks from many combinations of workstations and servers. This is one of the foundations for client-server computing.

What does this mean to you as a Windows developer? Let's take a look at the various communication mechanisms available in Windows for Workgroups (abbreviated to 'Workgroups' for the rest of the article).

Architecture

Workgroups offers peer-to-peer networking services such as file and printer sharing. These services are fairly obvious to the user. However, Workgroups also offers a wide variety of communications services to programmers.

The implementation of Workgroups follows the general strategy of layered communications protocols, in the spirit of the OSI seven-layer model. The protocol stack, NetBIOS session over NetBEUI transport over NDIS drivers, borrows heavily from existing DOS LAN Manager client software. (This simplifies integration of Workgroups with LAN Manager servers, which cannot hurt sales prospects for the latter).

```
// AHEM.C - Simple alert program
//          using mailslots
//
// usage:  ahem [\\machinename] any message
//
// Requires LAN Manager toolkit to build
//

// LAN Manager Toolkit includes

#define     INCL_NETERRORS
#define     INCL_NETMAILSLOT
#include    <lan.h>

// C run-time

#include    <stdio.h>
#include    <stdlib.h>
#include    <string.h>

// Mailslot information

#define MAILSLOT_NAME    "\\MAILSLOT\\AHEM"
#define MESSAGE_CLASS    2
#define MESSAGE_PRIORITY 5
#define MESSAGE_TIMEOUT  0

// Entry point

int main(int argc, char *argv[])
{
  char * machine_prefix;
  char   slot_name[128];
  // Message to send
  char msg[128];
  // API return code
  API_RET_TYPE   uReturnCode;
  int i;

  // Check arguments

  if (argc==2 && strcmp(argv[1], "/?")==0)
  {
    fprintf(stderr, "ahem"
      " [\\Computername] any message\n");
    exit(0);
  }

  // Build message, check for \\ prefix

  machine_prefix="";
  msg[0]='\0';
  for (i=1; i<argc; i++)
  {
    if (i==1 && strstr(argv[1], "\\\\")
                              ==argv[1])
    {
       machine_prefix=argv[1];
    }
    else
    {
       strcat(msg, argv[i]);
       strcat(msg, " ");
    }
  }
  strcpy(slot_name, machine_prefix);
  strcat(slot_name, MAILSLOT_NAME);

  // Send the message

  uReturnCode = DosWriteMailslot(
    slot_name,      // Mailslot name
    (void *)&msg,   // Message to write
    strlen(msg)+1,  // Length; allow for \0
    MESSAGE_PRIORITY,
    MESSAGE_CLASS,
    MESSAGE_TIMEOUT);

  // Check result code

  if (uReturnCode != 0)
    printf("DosWriteMailslot error %u\n",
               uReturnCode);

  return uReturnCode; // Zero if OK
}
```

Figure 1 - AHEM.C

APIs

Several of the DOS LAN Manager Client APIs have passed over to Workgroups with minor changes:

- Named Pipes
- Mailslots
- NetBIOS

Although not part of the standard protocol stack, Workgroups can also be configured with:

- NetWare IPX/SPX
- TCP/IP

Workgroups also has Windows-specific services:

- Network DDE
- Generic Windows network calls

Several of these APIs can be used by both DOS and Windows applications, and can be used to communicate between these two kinds of applications, whether or not they are running on the same workstation.

Workgroups and NT

Many of the facilities currently present in Workgroups will also be present in Windows NT, which, even in its standard form, will have network capability. Windows NT is interoperable with Workgroups and many of the APIs are available on both platforms.

However, it should be noted that Windows NT redefines a number of the APIs presented in this article, either for performance or security reasons.

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➤ CIRCLE NO. 906

```
' Broken lines indicated using _
' space underscore sequence

Begin Form FRM_AhemServer
   Caption         =   "Ahem! Server"
   Height          =   1080
   Icon            =   AHEMSRV.FRX:0000
   Left            =   1440
   LinkTopic       =   "Form1"
   ScaleHeight     =   675
   ScaleWidth      =   2520
   Top             =   1920
   Width           =   2640
   WindowState     =   1  'Minimized
   Begin Timer TMR_Poll
      Interval        =   1000
      Left            =   120
      Top             =   60
   End
End
Option Explicit

' Handle for the mailslot
Dim hMail As Integer

'
' Check the API return code for non-zero
' and print error message if necessary,
' otherwise continue
'
Sub APICheck (action As String, _
          nResult As Integer)
  If nResult <> 0 Then
    MsgBox action & " : " & nResult, _
      16, "Error"
  End If
End Sub

'
' Initialise - create mailslot
'
Sub Form_Load ()
  APICheck "DosMakeMailslot", _
    DosMakeMailslot("\MAILSLOT\AHEM", _
                    256, 0, hMail)
End Sub

'
' Quit - delete mailslot
'
Sub Form_Unload (Cancel As Integer)
  APICheck "DosDeleteMailslot", _
           DosDeleteMailslot(hMail)
End Sub

'
' Call at regular intervals to see if
' a message has arrived at the mailslot
'
Sub PollMailSlot ()

  Dim Buff As AHEM_MSG
  Dim nResult As Integer
  Dim bytesread As Integer
  Dim nextsize As Integer
  Dim nextprio As Integer

  ' Check mailslot exists
  If hMail = 0 Then Exit Sub

  Do
    nResult = DosReadMailslot(hMail, Buff, _
           bytesread, nextsize, nextprio, 0)
    If nResult = ERROR_Timeout Then
      ' Nothing in mailslot
      Exit Do
    ElseIf nResult = 0 Then
      ' Got something
      MsgBox Buff.Msg, , "Ahem!"
    Else  ' Some error
      APICheck "DosReadMailslot", nResult
    End If
  Loop

End Sub

'
' Timer trigger
'
Sub TMR_Poll_Timer ()
  PollMailSlot
End Sub
```

Figure 2 : AHEMSRV.FRM listing

network, and the activities of other machines to which you can be connected, to name a few. In the worst case, if your application waits for an incoming message and that message is never sent, a simple 'receive data' call can wait forever.

In a true multi-tasking operating system there are no problems. It's no problem for an application to be held up during a network call, because the OS will suspend ('block') the application until it can be completed, and other applications will be dispatched. Many of the newer operating systems, eg OS/2 or Windows NT, permit multiple threads per process, which allows the programmer a finer control over scheduling within the program. Multithreading allows the programmer to allocate one thread to each communication sub-task.

```
'
' Mailslot API routines
'
' Broken lines indicated using
' space underscore sequence

Declare Function DosMakeMailslot _
    Lib "NETAPI" _
   (ByVal lpszName$, ByVal msgsize%, _
    ByVal slotsize%, hMail%) As Integer
Declare Function DosDeleteMailslot _
    Lib "NETAPI" _
    (ByVal hMail%) As Integer
Declare Function DosMailslotInfo _
    Lib "NETAPI" _
    (ByVal hMail%, msgsize%, slotsize%, _
     nextsize%, nextprio%, nMesg%) As Integer
Declare Function DosPeekMailslot _
    Lib "NETAPI" _
    (ByVal hMail%, lpBuff As Any, _
     cbReturned%, cbNext%, _
     nextprio%) As Integer
Declare Function DosReadMailslot _
    Lib "NETAPI" _
    (ByVal hMail%, lpBuff As Any, _
     cbReturned%, cbNext%, nextprio%, _
     ByVal timeout&) As Integer
Declare Function DosWriteMailslot _
    Lib "NETAPI" _
    (ByVal lpszName$, lpBuff As Any, _
     ByVal bufsize%, ByVal prio%, _
    ByVal class%, ByVal timeout&) As Integer
```

Figure 3 - WFW.BAS listing

However, current 16-bit implementations of Windows are not preëmptive; a blocked application holds up all the others - a serious problem. There are several potential solutions:

- 'Block and be damned'. Applications adopting this approach are not popular.
- Start the operation but do not wait for completion (most APIs allow this). Poll for completion using system idle time (using `PeekMessage()`) or at regular intervals (timers).
- Start the operation, and request an interrupt-time callback on completion. This is very awkward because Windows is, on the whole, not reëntrant: with very few exceptions, you can't make Windows calls inside an interrupt handler.

For all but the most trivial of programs, the last two approaches should be used. An application must keep track of the current state of all connections. For an application with many conversations this might involves state tables.

Mailslots

A mailslot is a one-way connectionless communication interface. One side of the conversation creates a mailslot to receive messages, and waits for a message. The other side writes messages to that mailslot. Each message is transmitted independently, and the order of delivery is not guaranteed.

Mailslot names must have the form `\MAILSLOT\x`. When sending a message to a local mailslot, the program specifies a name in this format. When sending a message to a remote mailslot, the computer name is added to the front of the mailslot name, thus: `\\MACHINE\MAILSLOT\x`.

Traditional LAN Manager mailslot messages have two 'classes'. First class mail is guaranteed delivery: the write operation blocks until the message has arrived or a time-out expires. Second class message calls complete when the message has been successfully placed on the network or an error occurs. If a message is sent but could not be delivered, the sender of the a second class message is none the wiser.

Despite this drawback, second class messages have a number of uses:

- No time is spent sending acknowledgements, thus increasing efficiency.
- Any machine can receive second class messages (only a LAN Manager server can receive first class messages).
- They can be broadcast across the workgroup, using an asterisk for the machine name.

The mailslot API addresses the blocking problem by specifying a time-out for calls which might block. An application can also use zero-length time-outs and poll for activity on the mailslot.

Windows programs can access the Mailslot API through the NETAPI DLL; DOS applications have an INT 21 interface, for which the LAN Manager Programmer's Toolkit has C bindings.

Windows NT does not support the idea of mailslot message class - all messages are second class, and there are no time-outs or priorities. The API has been redefined to take account of these issues and also security.

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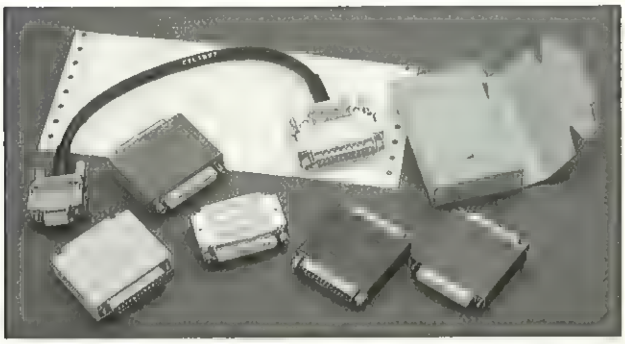

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```
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Begin Form FRM_Resources
   Caption         =   "Windows Resources"
   Height          =   1680
   Left            =   960
   LinkMode        =   1  'Source
   LinkTopic       =   "WinRes"
   ScaleHeight     =   1275
   ScaleWidth      =   5640
   Top             =   1080
   Width           =   5760
   Begin Timer TMR_Tick
      Interval        =   1000
      Left            =   5940
      Top             =   240
   End
   Begin Gauge GGE_GDI
      Autosize        =   -1  'True
      Height          =   315
      InnerBottom     =   5
      InnerLeft       =   5
      InnerRight      =   5
      InnerTop        =   5
      Left            =   2100
      Max             =   100
      NeedleWidth     =   1
      TabIndex        =   1
      Top             =   720
      Width           =   3255
   End
   Begin Gauge GGE_User
      Autosize        =   -1  'True
      Height          =   315
      InnerBottom     =   5
      InnerLeft       =   5
      InnerRight      =   5
      InnerTop        =   5
      Left            =   2100
      Max             =   100
      NeedleWidth     =   1
      TabIndex        =   0
      Top             =   120
      Width           =   3255
   End
   Begin Label GDI
      Height          =   315
      Left            =   1140
      TabIndex        =   5
      Top             =   720
      Width           =   795
   End
   Begin Label User
      Height          =   315
      Left            =   1140
      TabIndex        =   4
      Top             =   120
      Width           =   795
   End
   Begin Label LBL_User
      Caption         =   "User"
      Height          =   315
      Left            =   240
      TabIndex        =   3
      Top             =   120
      Width           =   735
   End
   Begin Label LBL_GDI
      Caption         =   "GDI"
      Height          =   315
      Left            =   240
      TabIndex        =   2
      Top             =   720
      Width           =   735
   End
End
Option Explicit


Declare Function GetFreeSystemResources _
  Lib "User" _
  (ByVal fuSysResource As Integer) As Integer


Const GFSR_GDIRESOURCES = &H1
Const GFSR_USERRESOURCES = &H2


Sub TMR_Tick_Timer ()
    Dim U As Integer, G As Integer


    U = GetFreeSystemResources( _
                GFSR_GDIRESOURCES)
    GGE_User.Value = U
    User.Caption = U


    G = GetFreeSystemResources( _
                GFSR_USERRESOURCES)
    GGE_GDI.Value = G
    GDI.Caption = G
End Sub
```

Figure 4 - NETRES.FRM listing

It would appear from experiments conducted using Workgroups that *local* second class mailslot messages do have guaranteed delivery, and can also be delivered even if no network cards are installed. This makes the mailslot a useful communication tool for communicating between DOS sessions, or between DOS applications and Windows applications on the same machine.

The example programs AHEM and AHEMSRV illustrate mailslots. AHEM (Figure 1), a DOS application written in C, writes messages to a mailslot called `\MAILSLOT\AHEM`, which can be on the local machine by default, or on a remote machine: this is specified by entering a machine name as part of the AHEM command line. The additional headers and libraries are from the LAN Manager Programmer's toolkit.

AHEMSRV and WFW.BAS (Figure 2 and Figure 3), written in Visual Basic 2.0, create a mailslot and waits for messages to arrive. The blocking issue is solved by using a timer to check the mailslot regularly without a time-out.

Named Pipes

A named pipe is a point-to-point channel through which data may flow in either direction. Named pipes are created at one machine, referred to as the Server. A second machine, the Client, may open that named pipe.

Name pipes must have a name of the form `\PIPE\x`. When referring to a particular named pipe on a given machine, the syntax is `\\MACHINE\PIPE\x`.

But there is some bad news. Workgroups can only act as a named pipe client - it can use an existing named pipe created on a LAN Manager server or NT system, but cannot create named pipes itself. The blocking issues are addressed in the same way as for mailslots.

As with mailslots, the named pipe API is available to both DOS and Windows applications through INT 21 and NETAPI.DLL respectively. Named pipes are integrated with the file system in Windows NT: this is not the case for Workgroups.

DDE and Network DDE

Dynamic Data Exchange (DDE) has been around since Windows 2.0. It is a protocol based on the Windows message system. DDE hot-links two or more applications. One application acts as a data server and clients link to it, receiving new data whenever server data changes. DDE generally provides unidirectional data flow from server to client.

Networked DDE is a Workgroups innovation that extends DDE almost transparently across the LAN. Each workstation runs a gateway program, NETDDE.EXE, which converts between DDE's local protocol and a LAN session. A DDE topic can be made 'public' at a server machine. This is a little like sharing a disk directory in File Manager: a public name is given which is used by other machines. A client wishing to connect to a remote DDE source specifies the remote server's name in the form `\\MACHINE\NDDE$`, along with the public topic name and the item name.

The NetDDE API is packaged in an additional DLL, NDDEAPI.DLL, which provides a control interface for servers to create and manage shared topics. The Workgroups resource kit also contains the Network DDE Share Manager: a front-end tool for configuring NetDDE shares. This information is currently held in SYSTEM.INI but this may change in future.

The server itself knows nothing of networked DDE: the dirty work is done by the transfer program. Only the client end would need to know the name of the workstation on which the program was running.

The NetDDE API is not available to DOS applications.

NetDDE Example

The NETRES program (Figure 4) illustrates the use of Networked DDE to monitor resource usage of a remote workstation. The Visual Basic program is a DDE source, continually monitoring the available system resources through the API call `GetFreeSystemResources()`. The information is available through two DDE items, accessed as:

- `NETRES|WinRes!GDI`
- `NETRES|WinRes!User`

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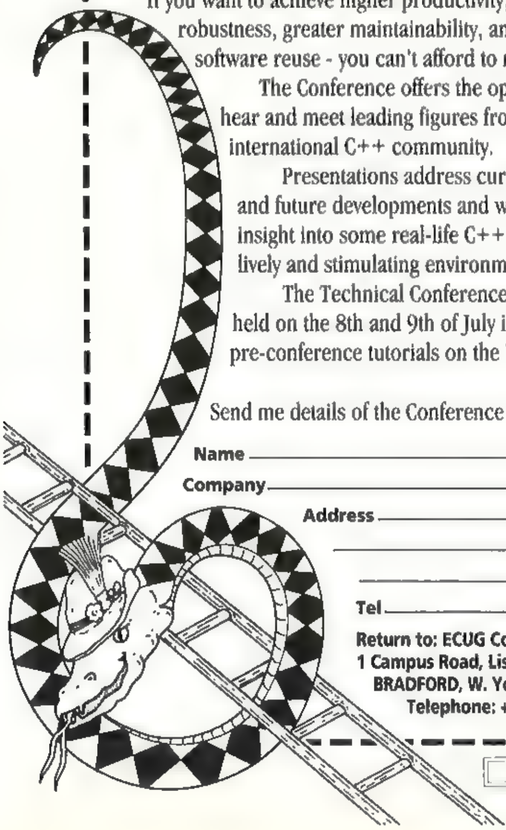

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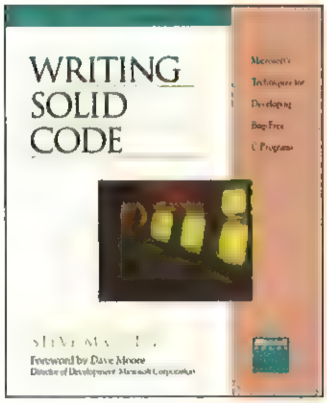

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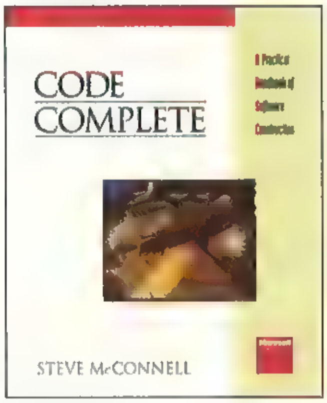

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which give the GDI and USER free space percentages respectively.

In order to make this information available to NetDDE clients, The relevant part of the SYSTEM.INI should appear as in Figure 5. By convention, a shared topic name on the server is the actual topic name with an appending '$' character.

As an example, if the program is running on a workstation called `FRED`, a DDE client program running on a remote workstation can access this information as `\\FRED\NDDE$|WinRes$!GDI` and `\\FRED\NDDE$|WinRes$!User`, eg as an Excel DDE formula.

Generic Network Calls

Even non-Workgroups versions of Windows have generic network support. A number of exported entry points in the USER module provide generic network support at a high level. Such facilities are required by standard Windows utilities such as Print Manager.

As a documented example, consider `WNetGetConnection`, which tells the application whether a resource has been redirected to a remote machine, and if so, how.

These routines are not extensively documented in the standard SDK, but are documented at the device driver level in the Device Driver Kit (DDK).

Workgroups extends this API, adding support for reading the network configuration, automatic Workgroups logon, password management and the like.

NetBIOS

NetBIOS (the Network Basic Input Output System) is a session-level API. Mailslots, named pipes, network DDE and the redirector use NetBIOS services. NetBIOS is one of the most common network APIs for the PC, having been defined for the earliest IBM networks in the mid 1980s, and subsequently adopted or emulated in many other systems.

```
[DDEShares]

WINRES$=NETRES,WINRES,,31,,0,,0,0,0
```

Figure 5 - Configuring SYSTEM.INI for sharing the NetRes program

The NetBIOS API consists of submitting network control blocks (NCBs) through a DOS software interrupt or the `NetBIOSCall()` Windows entry point. Non-blocking calls to NetBIOS are complex: NetBIOS can notify the caller that a non-blocking call has terminated using an interrupt-time callback. In practice, any Windows application using callbacks must place them in a DLL, and the callback routine posts a Windows message.

TCP/IP

TCP/IP is not part of the standard Workgroups product. However, the Workgroups Resource Kit describes how to configure Microsoft's TCP/IP (supplied with LAN Manager) into a Workgroups machine. A Workgroups-specific version of Microsoft TCP/IP is expected but no further details were available at the time of writing.

TCP/IP itself defines no API, but various interfaces exist. The WinSock interface has been defined as a Windows-friendly interface to TCP/IP, based on the Berkeley UNIX 'sockets' library. The main differences between WinSock and the traditional BSD socket library are:

- WinSock sockets are not implemented as part of the file system; UNIX-style read and write calls cannot be used on sockets.
- WinSock provides automatic polling and yield facilities to solve the blocking problem; BSD socket calls use UNIX scheduling services.

A number of non-Microsoft implementations of TCP/IP exist, and it is hoped that WinSock will become a standard interface for these too.

NetWare

Workgroups also has its own implementation of the IPX/SPX protocol stack and ships with Novell's NETX redirector. NetWare API calls are available to DOS and Windows, through software interrupts and NETWARE.DLL.

NetWare is not integrated into Workgroups as well as LAN Manager. This reflects to some extent the differing architectures and protocols, and also the political and commercial rivalries between Microsoft and Novell.

Conclusion

Workgroups contains a rich LAN API with many standard interfaces and protocols. Although restricted by a non-preëmptive environment, it points to a future in which communications will play an important role in PC development.

EXE

Robert Seeman is a consultant and instructor working for QA Training Limited in Cirencester, where he specialises in Windows application development and client-server systems. He can be contacted on 0285 655888, or emailed as rseeman@qatrain.mhs.compuserve.com.

Thanks to Alex Shipp of QA for his help in preparing this article.

References: *Client/Server Programming with OS/2 2.0 (2nd Ed., Orfali and Harkey, Van Nostrand Reinhold), though not Windows-specific, is an excellent overview of the PC's communication potential with lots of theory and practical code.*

The 'official' Windows for Workgroups SDK contains documentation, header files, library files and so on. It is available eg from CIX (in windows/files, WFWSDK.ZIP). If you want to develop Windows-only applications, this will be sufficient - the libraries are import libraries covering the API. If you want to build DOS applications, such as AHEM.C in this article, you will need to get a .LIB file which contains a statically linked DOS version of the API. This is available in the LAN Manager Programmer's Toolkit. Alternatively, you can roll your own library from Ralph Brown's Interrupt Listing which documents the INT 21 entry points from DOS (CIX again, exe/files INTER35A.ZIP et seq).

LAN Manager Programmer's Reference *and* LAN Manager, A Programmer's Guide *(Microsoft Press) are a useful source of information on the LAN Manager API. The books are part of the LAN Manager Toolkit.*

The WinSock specification is available from Microsoft or from the CompuServe MSNETWORKS forum.

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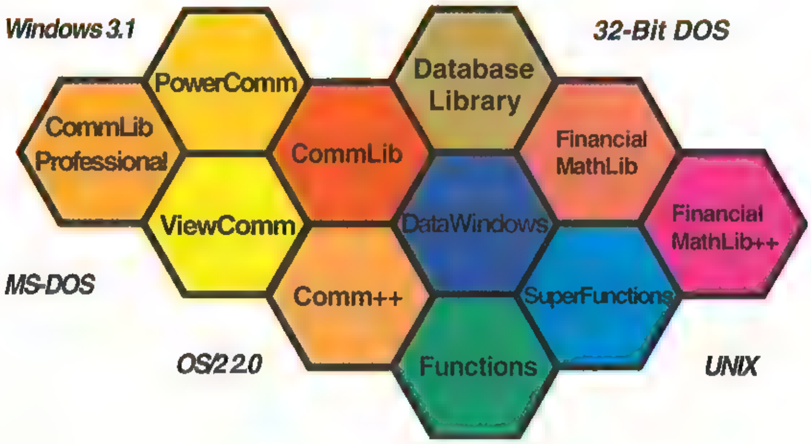

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A Mouse's Tale

Dave Mansell was so impressed when he first saw the Norton Utilities smooth mouse handling in text mode that, instead of buying the company, he wrote his own version.

The first time I saw a 'graphic arrow' mouse cursor being used in text mode was in the famous Norton Utilities, V5.0. At first it looked as though Peter 'The Shirt' Norton had achieved the impossible. Instead of the usual cell 'block' character, jumping clumsily from one position to the next on the 80x25 screen matrix, there was a proper animated arrow shape, creeping around the display pixel-by-pixel. Not only does this look good, it also makes using the mouse noticeably easier.

On reflection, I began to get an idea of how it could be done. At the time I was too busy to follow this idea up, but recently I needed to write some text user interface code and decided to have a go at producing a graphics cursor in text mode as part of the project. That code forms the basis of this article.

There have been some published examples of doing this in C and assembler, but I thought it would be fun to code as much as possible in C++, implementing a Mouse class to handle it. We will still have to resort to some assembler, but I have tried to keep it to an absolute minimum.

This article will consist of two parts. In this first part, I present a class that encapsulates the functions of the standard Microsoft mouse driver. This will give us a base class. The 'graphics' cursor class will be derived from this in the second part of the article in the next issue. There are good reasons for this design. There are circumstances when we will want to abandon our 'graphics' cursor in favour of a standard text cursor. A notable example is a program running in a windowed DOS box under Microsoft Windows using a simulated text screen. A 'graphics' cursor created using these techniques does not display correctly.

MS-DOS Mouse

I'll begin with some background on using a mouse under text mode MS-DOS. Programming a mouse involves using the facilities provided by the Microsoft Mouse Driver. The functions offered by this driver have become a *de facto* standard and are supported by virtually all manufacturers of PC mice. The mouse driver is usually installed at system start-up, either in CONFIG.SYS ('DEVICE=MOUSE.SYS') or AUTOEXEC.BAT.

An application program talks to the mouse driver via an 8086 software interrupt, int 0x33 (51 decimal). Using this interrupt, the application can obtain information about the position of the mouse cursor, the state of the mouse buttons (ie whether they are pressed) and can alter various parameters such as the mouse sensitivity. The interface is documented in many books, eg *PC Interrupts* (pub Addison-Wesley, ISBN 0-201-57797-6), and will not be detailed here.

The first stage is to create a C++ class to handle the standard text and graphics mode hardware mouse cursors. This will support all of the functions available from the mouse driver, including the installation of a 'callback function'. This is called by the mouse driver whenever a mouse event (such as mouse movement or a button press) occurs.

In addition to the mouse classes, I have created a simple `Rectangle` class to describe a rectangle on the screen. The header for this, RECT.HPP, is shown in Figure 1 - the (straightforward) implementation has been omitted to save space. Feel free to replace this class with your own equivalent if you have one, modifying the `TMouse` code as needed.

```
// Prevent multiple inclusions

#ifndef _RECT_HPP
#define _RECT_HPP

typedef unsigned short ushort;
typedef unsigned char uchar;

class Rectangle
{
public:
  Rectangle() { set(0,0,1,1); }
  Rectangle(ushort y1,ushort x1,
            ushort y2,ushort x2)
    { set(y1,x1,y2,x2); }
  void set(ushort y1,ushort x1,
           ushort y2,ushort x2);
  virtual int is_inside(ushort row, ushort col);

  ushort height, width;
  ushort trow, brow, lcol, rcol;
};

#endif
```

Figure 1 - RECT.HPP

TMouse

The header file for our main class, TMOUSE.HPP, is shown in Figure 2. The class `TMouse` consists of a constructor and destructor, together with a number of public functions and some protected functions and data variables. `TMouse` hides the mechanics of the mouse driver from our application, providing a clean interface.

The link between `TMouse` and the mouse driver is the protected member function `driver()`. This encapsulates the int 0x33 call, using the `mouse_regs` variable to provide input data for the standard C function `int86()`. All of the functions that talk

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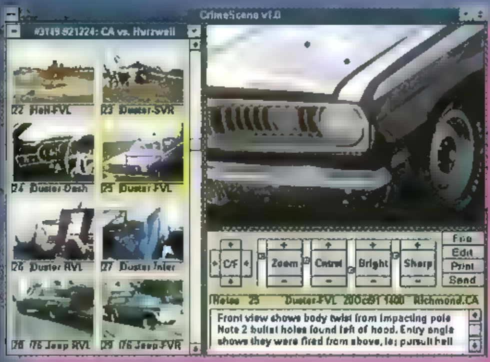

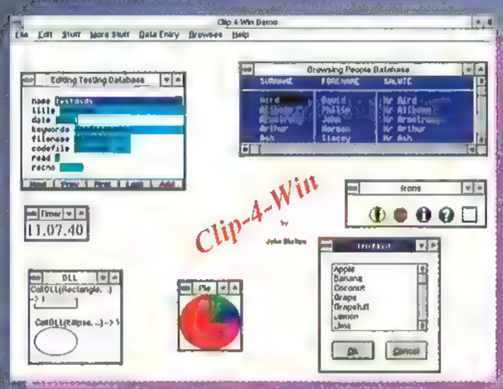

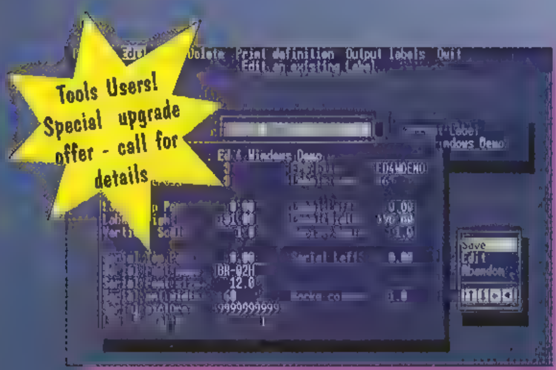

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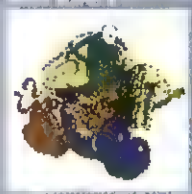

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to the mouse driver use it, except for `setgraphcursor()`. This needs to pass the address of the cursor mask in segment registers, and so calls `int86x()` directly.

Implementation

As you can see, `TMouse` implements many of its member functions `inline` in the header file. The rest are implemented in TMOUSE.CPP (Figure 3).

At the start of TMOUSE.CPP is a group of macros that simplify access to the BIOS data area at address 0x400. This area is used by the IBM PC BIOS to store data about the equipment configuration, including the current video mode, number of displayed columns and rows, and the point size of a character cell when the display is in a text mode.

Following this we have the declaration `a_installmouse()`. This is actually an assembly language helper function, implemented in TMOUSE_A.ASM. It's declared as a C function so that we don't have to worry about things like calling conventions, name-mangling and `this` pointers. Its purpose is to store the address of a function to be called by an assembly language routine tied to the mouse interrupt. More detail later.

At first it looked as though Peter 'The Shirt' Norton had achieved the impossible

`TMouse` includes a number of public functions. I'll go through these in detail so that you can use them in your programs.

The constructor, `TMouse::TMouse()`, ensures that there is only ever one instance of `TMouse` active at any time. It does this by asserting that the static data member `CurMouse` must be 0 before any class initialisation. A static data member, you'll recall, has the property that there is only ever one instance of it shared between all instances of class. This is initialised at the start of TMOUSE.CPP to '0', and set to the address of the `TMouse` instance in the constructor. An attempt to create a second instance of a `TMouse` causes the assert to trip, since CurMouse is not 0.

```
#ifndef TMOUSE_HPP
#define TMOUSE HPP

#include <dos.h>
#include "rect.hpp"
#include "cursors hpp"

class TMouse
{
public:
  TMouse();
  virtual ~TMouse()
     { CurMouse = 0; driver(); }

  int isactive() { return ismouse; }

  int getstatus(unsigned *curposx,
                unsigned *curposy);

  void readcounters(int *countx,
                    int *county);

  virtual void install_callback(
    void (cdecl *callback)
      (unsigned reason, unsigned state,
       unsigned curx, unsigned cury),
    unsigned short mask = 255);

  virtual void showcursor(void);
  virtual void hidecursor(void);
  virtual void hidecursor(Rectangle crect);

  void set(unsigned curposx,
           unsigned curposy)
    { driver(4, 0, curposx*hpoints,
                   curposy*vpoints/2); }

  void getpress(unsigned *count,
                unsigned *curposx,
                unsigned *curposy)
    { pr_info(5, count, curposx, curposy); }

  void getrelease(unsigned *count,
                  unsigned *curposx,
                  unsigned *curposy)
    { pr_info(6, count, curposx, curposy); }

  void setbounds(Rectangle srect);

  void setgraphshape(int hotspotx,
                     int hotspoty,
                     CursorMask &mask);

  void settextshape(int select,
                    int start,
                    int stop)
    { driver(10, select, start, stop); }

  void lightpen(int flag)
    { (flag == 0) ? driver(14):driver(13); }

  void setratio(unsigned ratiox,
                unsigned ratioy)
    { driver(15, 0, ratiox, ratioy); }

  void setthreshhold(unsigned threshhold)
    { driver(19, 0, 0, threshhold); }

  static TMouse *getmouse(void)
    { return CurMouse; }

protected:
  union REGS mouse_regs;
  unsigned short ismouse;
  unsigned short ishidden;
  unsigned short mrows, mcols,
                 hpoints, vpoints;

  int isgraphics(void);

  void driver(int val_ax = 0,
              int val_bx = 0,
              int val_cx = 0,
              int val dx = 0);

  void pr_info(int func, unsigned *count,
               unsigned *cpx, unsigned *cpy);

  static TMouse *CurMouse;
};

void far mouse_isr(void);

#endif
```

Figure 2 - TMOUSE.HPP

After setting up `CurMouse`, the constructor determines whether the display is in text or graphics mode (by calling `isgraphics()`), and sets default row, column and point variables accordingly. The protected function `isgraphics()` works by pulling the current video mode number out of the BIOS data area and comparing it with a list of known text modes.

`TMouse::driver()`, briefly mentioned above, is a protected function used to simplify access to the mouse through interrupt 0x33. It sets up the registers required by the relevant sub-function, then calls `int86()` to do the business. If you would rather be quick than portable, you can optimise this function through the use, eg, of pseudo-registers and `geninterrupt()`.

If you look in TMOUSE.HPP, you will see that the last three parameters have default values of 0. This means you can call the function with values for only those registers needed for the sub-function you want.

The public function `TMouse::getstatus()` uses sub-function 3 of the int 0x33 mouse interface to obtain the current mouse status. This information includes the current cursor position and the position of the mouse buttons. This last bit of data is stored as a bit pattern in a single byte. One bit is assigned to each mouse button; a '1' indicates that the button is down.

`TMouse::readcounters()` reads the mouse motion counters. These indicate how far the mouse has moved, in 'mickeys' (1/200ths of an inch), since the last call to this function. It takes two pointers to integers as arguments, in which are stored the motion counts in the x and y directions.

`TMouse::showcursor()` and `TMouse::hidecursor()` show/hide the mouse cursor. You should

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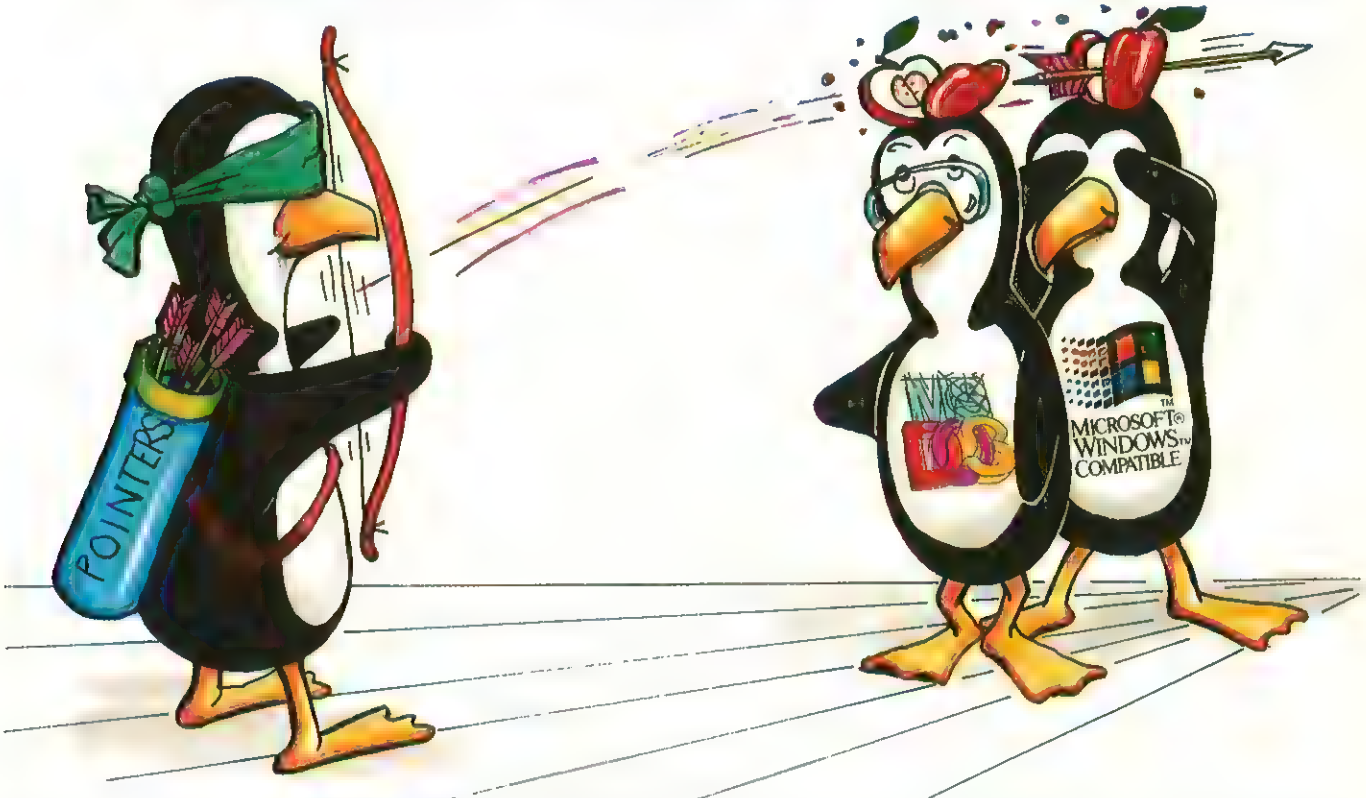

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always hide the mouse cursor during any screen update so that you do not leave 'mouse tracks' on the display. These are implemented so that they can be nested. Each call to `hidecursor()` should have a corresponding call to `showcursor()`. The cursor is only displayed when all the nested pairs have been exited. The private variable `ishidden` is a counter used to control whether the cursor is displayed or hidden it works like a count on a semaphore.

There is a second version of `TMouse::hidecursor()` that takes a `Rectangle` as an argument. This uses a sub function of the mouse driver to hide the mouse cursor when it moves into a selected rectangle on the screen. This works independently of the standard `showcursor()` and `hidecursor()` functions. It can be used when updating a window.

`TMouse::set()` moves the mouse cursor to a particular position on the display. For instance, you might use `set(20,10)` to position the mouse at column 20, row 10 on the screen. This function uses int 33h sub-function 4 to set the position and is implemented as an inline call.

`TMouse::getpress()` and `TMouse::getrelease()` get information about button presses and releases from the mouse driver. Both these functions take three pointers as arguments. The first points to an unsigned integer that holds the number of the button you are asking about. When the function returns, this parameter holds the number of presses/releases since the last time it was called. The other pointers refer to variables which contain the mouse position at last press or release. If you look at the source, you will see that both `getpress()` and `getrelease()` use a private internal helper function, `getpr()`, to avoid duplicating code.

`TMouse::setbounds()` restricts the mouse cursor to the specified area. Most often this is used to prevent the mouse cursor from moving outside the displayed screen area. For ease of use, this function takes a `Rectangle` as its argument.

Cursor shapes

`TMouse::settextshape()` defines a mask for the cursor for text mode. Normally you can only define a cursor that uses an existing display character from the hardware character set with a complementary attribute (known as an attribute cursor), or block or line cursors of various thicknesses (known as a hardware text cur-

```
#include <stdlib.h>
#include <dos.h>
#include <assert.h>
#include "tmouse.hpp"

#define BIOS_POINTS \
  *((unsigned char far *) 0x00400085L)
#define BIOS_COLS \
  *((unsigned char far *) 0x0040004AL)
#define BIOS_ROWS \
  *((unsigned char far *) 0x00400084L)
#define BIOS_MODE \
  *((unsigned char far *) 0x00400049L)

// This function is in TMOUSE_A.ASM.
// It is declared as a C function
// so that we can forget name mangling.
extern "C" {
void _cdecl a_installmouse(
  unsigned short,
  void (_cdecl *)(unsigned, unsigned,
                  unsigned, unsigned),
  void *);
}

// used by TMouse::isgraphics
const int NumTextModes = 5;
static int TextModes[NumTextModes] =
          { 1, 2, 3, 7, 15 };

// initialize static member
TMouse *TMouse::CurMouse = NULL;

TMouse::TMouse()
{
  // Only one mouse allowed
  assert(CurMouse == NULL);
  CurMouse = this;
  ishidden = 1;

  long far *fp = (long far *) 0x000000ccL;

  // Some versions of DOS have 0 in the
  // vector table for int33
  mouse_regs.x.ax = 0;
  if (*fp != 0L)
  {
    ismouse  = 1;
    driver(0);
  }
  ismouse = (mouse_regs.x.ax != 0);


  if (isgraphics()) {
    mrows = 200;
    mcols = 640;
    hpoints = vpoints = 1;
    if (BIOS_ROWS != 0) {
      mrows = BIOS_ROWS + 1;
      mcols = BIOS_COLS;
    }
  } else {
    mrows = 24;
    mcols = 80;
    hpoints = vpoints = 8;
    if (BIOS_ROWS != 0) {
      mrows = BIOS_ROWS + 1;
      mcols = BIOS_COLS;
      vpoints = BIOS_POINTS;
    }
  }
}

int TMouse::isgraphics()
{
  int mode = BIOS_MODE;

  for (int i = 0; i < NumTextModes; i++)
    if (TextModes[i] == mode)
      return 0;
    return 1;
}

void TMouse::driver(int val_ax, int
val_bx,
                   int val_cx, int val_dx)
{
  if (ismouse)
  {
    mouse_regs.x.ax = val_ax;
    mouse_regs.x.bx = val_bx;
    mouse_regs.x.cx = val_cx;
    mouse_regs.x.dx = val_dx;
    int86(0x33, &mouse_regs, &mouse_regs);
  }
}

int TMouse::getstatus(unsigned *curposx,
                      unsigned *curposy)
{

  driver(3);
  *curposx = (mouse_regs.x.cx)/hpoints;
  *curposy = (mouse_regs.x.dx)/vpoints;
  return mouse_regs.x.bx;
}

void TMouse::pr_info(int func,
                     unsigned *count,
                     unsigned *curposx,
                     unsigned *curposy)
{
  driver(func, *count);
  *count = mouse_regs.x.bx;
  *curposx = (mouse_regs.x.cx)/hpoints;
  *curposy = (mouse_regs.x.dx)/vpoints;
}

void TMouse::showcursor(void)
{
  if (ishidden)
  {
    ishidden--;
    if (ishidden == 0)
      driver(1);
  }
}

void TMouse::hidecursor(void)
{
  if (ishidden == 0)
    driver(2);
  ishidden++;
}

void TMouse::setgraphshape(int hotspotx,
                           int hotspoty,
                           CursorMask
&mask)
{
  struct SREGS sregs;

  if (ismouse)
  {
    mouse_regs.x.bx = hotspotx;
    mouse_regs.x.cx = hotspoty;
    sregs.es = FP_SEG(mask.screenmask);
    sregs.ds = FP_SEG(mask.screenmask);
    mouse_regs.x.dx =
               FP_OFF(mask.screenmask);
    int86x(0x33, &mouse_regs,
          &mouse_regs, &sregs);
  }
}

void TMouse::readcounters(int *countx,
                          int *county)
{
  driver(11);
  *countx = mouse_regs.x.cx;
  *county = mouse_regs.x.dx;
}

void TMouse::setbounds(Rectangle srect)
{
  driver(7, 0, srect.lcol*hpoints,
           srect.rcol*hpoints);
  driver(8, 0, srect.trow*vpoints,
           srect.brow*vpoints);
}

void TMouse::hidecursor(Rectangle crect)
{
  mouse_regs.x.si = crect.lcol*hpoints;
  mouse_regs.x.di = crect.trow*vpoints;
  driver(16, 0, crect.rcol*hpoints,
            crect.brow*vpoints);
}

// a_installmouse is in tmouse_a.asm

void TMouse::install_callback
  (void (cdecl *func)(unsigned reason,
                      unsigned state,
                      unsigned curx,
                      unsigned cury),
  unsigned short mask)
{
  static unsigned char stack[260];

  a_installmouse(mask, func, stack+260);
}
```

Figure 3 - TMOUSE.CPP

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sor). The first argument selects the cursor mode. A value of 1 indicates that the following arguments specify the start and end scan lines within a character block. A value of 0 means that the following arguments specify the character to use for the screen mask and cursor mask respectively of the attribute cursor. These specify the character to use, and how to merge its attribute with the underlying screen attribute.

`TMouse::setgraphshape()` defines a mask for the cursor to use in graphics mode. The default cursor is an arrow pointing upwards and tilted 45 degrees to the left. This function allows you to change the appearance of the graphics cursor. You could, for instance, change it so that it looks like an hourglass. The parameters `hotx` and `hoty` indicate where the 'hot spot' of the cursor is. The position of this point on the display indicates the position of the cursor.

The mask parameter takes a `CursorMask`, defined in CURSORS.HPP (not listed here - will be included next month). This consists of two integer arrays that define the shape of the cursor in 1s and 0s. The first array defines those parts of the cursor that are to be transparent, ie will allow the underlying display to show through; the second defines the actual shape of the cursor.

Now an obscure mouse function, which is included only for the sake of completeness. `TMouse::lightpen()` enables or disables mouse emulatation of a light pen. A non-zero argument turns the emulation on, and a zero argument turns it off. The pen is 'off the screen' when the left and right buttons are up, and on the screen when both buttons are down. I've never seen this used in a real application.

Bit	Event
0	Call if mouse moves
1	Call if the left button is pressed
2	Call if the left button is released
3	Call if the right button is pressed
4	Call if the right button is released
5	Call if the middle button is pressed*
6	Call if the middle button is released*

*Obviously, bits 5 and 6 apply only to three button mice.

Figure 4 - Mapping mouse events to mask bits

`TMouse::setratio()` changes the sensitivity of the mouse. It does this by altering the mickey/pixel ratio. The lower the value of this ratio, the more the cursor will move for the same size movement of the mouse.

Although it's included for completeness, I've never seen the obscure lightpen mouse function used in a real application

In a similar vein, `TMouse::setthreshold()` sets the speed at which the mickey/pixel value temporarily halves so that the mouse cursor moves faster. This allows the mouse cursor to move quickly around a large display without losing sensitivity when manipulating small areas of the display. Speed is calculated in mickeys/second.

The penultimate function is `TMouse::install_callback()`. This gives the user of class `TMouse` access to a powerful feature of the mouse driver: the ability to install his own interrupt handler that is called whenever a mouse interrupt occurs. This can be when any interrupt occurs, or only when it is triggered by a particular mouse action, such as a button press.

Rather than just pass the address of the callback function straight to the mouse driver, class `TMouse` installs its own handler (written in assembly language) and then uses this to call the user's callback. Doing things this way seems to add further complication and, as I dropped down into assembler for speed, may appear contradictory. However, it has one big benefit: it allows us to set up a local stack for the callback, eliminating the chance of failure due to an overloaded program stack.

The `mask` argument determines for which mouse events the handler gets called. The various types of events are mapped to bits, as shown in Figure 4.

The final public function in class `TMouse` is a static function, `getmouse()`. Remember that you can call a static function even without an instance of the class. The benefit of providing one here is that it avoids the need to pass pointers to a `TMouse` object to any function that needs the mouse. The function can simply use

```
TMouse *mouse = TMouse::getmouse;
```

If there is no `TMouse` object in existence it will return NULL, allowing a mouse object to be created on demand.

End of Part 1

I have now built a class that will enable you to add mouse support to your C++ programs. If you send off for the software, you will also find a simple test program for the class, TEST.CPP, which displays a mouse cursor and prints information on the cursor position and status to the screen.

In the second half of this article, I will get to the 'sexy' bit: I will inherit a new class from `TMouse` that will give us a pixel addressed arrow cursor in text mode.

EXE

Dave Mansell is the Managing Director of Citadel Software Limited, a company that develops and markets C and C++ libraries. and author of the Greenleaf Comm++ communications library. He used to be Technical Director of Zortech up until that company's purchase by Symantec. Dave can be contacted on 0566 86037 or on Cix in the Citadel and Greenleaf conferences, where his username is 'dmansell'.

Dave's software, as described in this series of articles, is available in machine-readable form. Please send us a diskette and SAE, following the instructions given in column 1 of the Contents page. Mark your envelopes 'MOUSE'.

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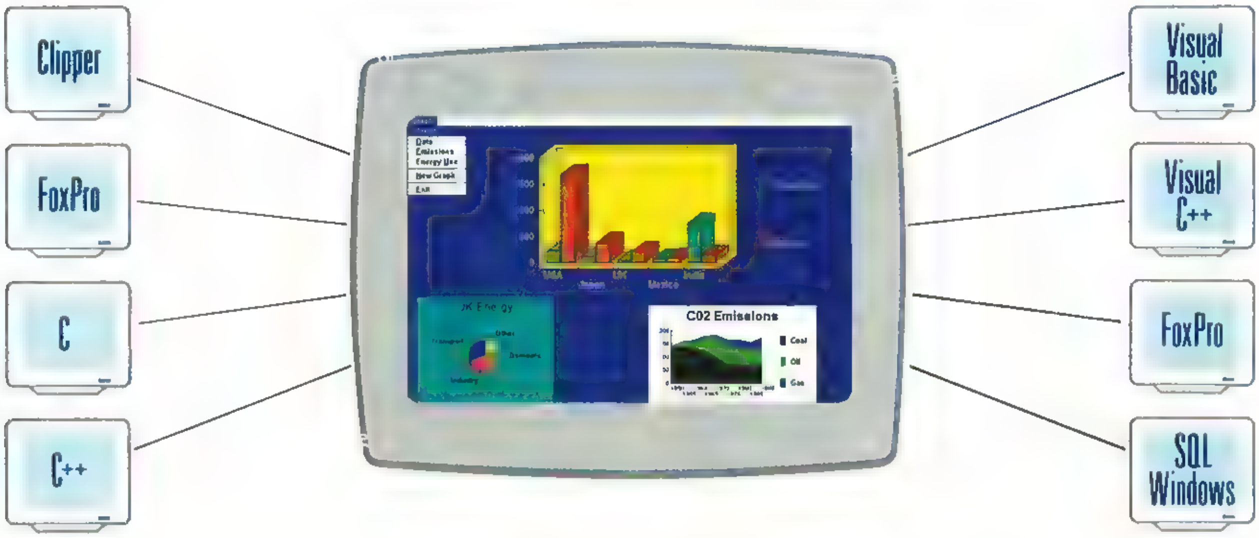

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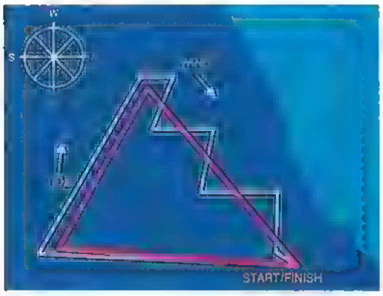

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Visual C++, The Small Print

Francis Glassborow takes a break from his CUG column to deliver the final low-down on Visual C++.

The obvious question for a reviewer of a product the size of Microsoft's Visual C++ is where to start. After much thought, I have come to the conclusion that I can do no better than a walk through highlighting the strengths and weaknesses that I have found during the last few months.

When I collected my pre-release (late beta) version from Microsoft it was just as well that my rucksack was large and empty and that I was in the best of health: the product was weighty. The release version is even heavier, with well over 6000 pages in ten manuals, together with a 290 page comprehensive index. Actually I was to learn later that even such a substantial index was not going to point me in all the right directions.

The release version comes on twenty 3.5" high density disks (a CD ROM version with everything including documentation is also available). When I installed these, I avoided the mistake I had made with the pre-release version by ensuring that I had a large number of buffers specified in my CONFIG.SYS file, and that I had disk caching enabled. Even so, installation took well over an hour. Like many, I first XCOPYed all the disks to my hard-drive (a large SCSI 1 GB 12ms drive with plenty of space). One pleasant surprise was to find that the set-up program handled the resultant 20 subdirectories (one per floppy disk) automatically. However this does not justify the time taken getting the material onto the hard-disk. The blame must lie with Microsoft which, for some reason, *still* does not archive its files.

First Sight

The first thing you will notice is that the old PWB has gone and been replaced by a glossy new IDE called Visual Workbench. Very soon you will come to realise that hiding among a number of real enhancements are some genuine frustrations. Why has MS provided an editor of such poor functionality that it would be hard put to find a place in the public domain arena? I am accustomed to editors that provide me a range of functionality including macros and folding. What I would like is an advanced syntax checking editor. Some compilers can be used to check syntax but those with previous experience of MS development tools will (rightly) suspect that the MSVC++ compiler is likely to be a court of last resort (ie take a little more time than usual to get all the semicolons in the right places).

Actually, in Microsoft's defence, they do provide a facility for adding your own editor to Visual Workbench. The problem is that you still have to go back to their offering when debugging, so this is not the answer.

All I can say about the Visual Workbench is that it provides a lot of desirable functionality, but you do need to spend a good deal of time exploring it because not everything is where you expect to find it. At least we do not have to fight nested menus that roll up at the drop of a feather. Most of your choices are made via nested dialog boxes (Borland, please note).

The Compiler

MSVC++ is far more tightly bound to the underlying operating system and Windows than earlier versions of MS C (and C++) compilers. MSVC++ is a package for developing products for Windows (later versions will aim at development for Windows' successors). In the battle between Windows NT and OS/2, this is a package that battles on the side of NT and its derivatives. If you have any thoughts about developing for OS/2, using this product will make moves in this direction (much) harder.

C++ enthusiasts should note that, like MSC\C++ 7, MSVC++ only supports the AT&T 2.1 version of Cfront. C++ has moved on some way since then and many exciting things like templates are in common use among C++ aficionados. The only advanced feature (beyond 2.1) that Microsoft adds is its version of exception handling (via preprocessor macros). Unfortunately, though there is still a lot of debate about this topic, the one method that the ANSI\ISO joint committee on C++ standardisation has decided not to use is that implemented by Microsoft.

If you are serious about learning advanced C++ techniques you should know that this compiler will not support much of the material that is being published by the 'experts'. Many features in MSVC++ are implemented via pre-processor macros; the current thinking in the C++ community is to eliminate the pre-processor.

A question that is bound to occur to many is whether this is MSC\C++ 8. If you watch the compiler messages carefully you will discover that the compiler thinks that it is. From what I can see, such a claim is rather overstating the issue in so far as changes to the compiler are concerned. It is more like a .2 or .3 upgrade - enough extras to introduce some new bugs and irritants (like issuing a warning message when encountering a correctly used I/O manipulator taking a parameter). Microsoft's decision to give the product a new name and start renumbering the releases from 1.0 is sensible, because nearly all the extra quality in this package is found in the supporting tools - more of these anon.

If you buy the professional version of MSVC++, you get full MS-DOS support including compiling a .EXE, .COM, p-code application and overlaying. I can say very little about these because they all seem to work as expected and I do not have an application large enough to test the overlay facility. I suspect that most programmers will choose to stick with whatever tried and tested overlay support they currently have.

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There is one eccentricity. The standard version offers no support for producing MS-DOS executables. With the demise of the Quick compilers, that means that there is no cheap entry point to DOS programming for those who wish (or whose programs require) the power of C/C++. When I tackled a Microsoft rep on this issue, he opined that, as all new users had Windows, they would naturally want to write programs for Windows. I think this is a serious blind spot. Many amateurs want the power of a language such as C because they are doing work in such areas as number theory, where the performance hit for using Windows is quite unacceptable.

In addition many professional programmers working in support areas, developing small utilities or providing extra functionality to a DOS application (databases spring to mind) have no use for Windows programming. Perhaps this omission says something about Microsoft's view of the World and the objectives its development tools are intended to support.

At least both versions of the package supports QuickWin style programming, so if you just want a quick-and-dirty program to do something, and do not mind it running in a Window, the tools are there.

Now I will leave these issues aside, because MSVC++ is not about writing programs in C or even in C++, it is about writing packages for Windows.

A Simple Windows App

Those of you who have used the Microsoft Foundation Classes found in MSC/C++ 7 will be delighted to see the new enhanced MFC 2.0. This is a massively improved version of MFC and lies at the heart of MSVC++. There are still rough edges, so we can expect MFC 2.1 to arrive at some time. With MFC 2.0, Microsoft has provided the basics for two major tools.

The first of these is the AppWizard which is used to build the framework for your new application. This is well named because it gives you a really magical start. No longer do you have to spend precious hours (more likely days or weeks) of development time getting such things as a toolbar, or printer functionality into your program. A few well documented steps and the AppWizard creates the multitude of files that are needed for your framework. Make any simple changes you want (none to start with, but as you gain experience you will have a few things that you want to tweak straight away) and you are ready to develop your own product.

Serious C++ users should know that this compiler will not support a lot of the material published by the 'experts'

Before you try to compile this framework, switch off all the extras you can locate - optimisers, debug code generation, browsers etc. Alternatively you could arrange a comfortable coffee break, because even on a relatively fast machine with reasonable disk performance and plenty of spare space (including 16 MB of RAM) a full build of an executable with debug code and full optimisation is time consuming (nearly four minutes on my 486/33 for an empty framework). It is actually much quicker to construct an empty but fully functional framework than it is to build an executable from it. Clearly this is not a product for a low-end 386SX machine.

Using AppStudio

It is very unlikely that the framework that you have produced will include all the resources that you need, so you will want to edit your resources file. AppStudio is the tool provided to add resources. You do not need to bounce back and forth between Editor and AppStudio via program manager, there is an option in the Options:Editor dialog that allows you to specify that AppStudio is to be used to open .RC (resource) files.

ClassWizard

This is not the place to go into details about writing Windows applications. Suffice to say that your program must handle its interaction with Windows via reactions to a range of messages. Experienced Windows programmers know that the whole process of creating and maintaining message handling functions is one that fills them with a longing to find another way of earning their living.

Much of the work is repetitive and hardly needs the intelligence associated with good programming. The very fact that it is repetitive invites the use of a computer to do it. Essentially this is what the ClassWizard does. The programmer provides the intelligence and ClassWizard provides the underlying common code (documented) together with comments indicating spots that need human action. It is not perfect and it will take you a little time to explore all the facilities but it will be time well spent.

Now that much of the burden of Windows application programming has been semi-automated your skills are released to tackle the functionality that your application will provide.

Other Tools

The debug support is improved. The ability to single-step, step into a function, out of it and over it with a single click on the tool bar adds to your feeling of control. The ability to view the call stack can be useful.

There is a good quality code browser. it is well worth the time and effort that it takes to learn to use it.

MSVC++ as a Whole

By now you may have some ideas about how I feel about this product but it is time for me to dot the i's and cross the t's.

MSVC++ is clearly a set of tools for writing Windows applications. In order to write such applications you need a compiler and one has been included. It comes from a long heritage of MS compilers and shows evidence that Microsoft is learning from experience. It is still relatively slow, though it does provide a substantial range of optimisations. These include a first shot at supporting smart-linking.

Smart-linking is a method by which functions that have not been used in an application are not included in the

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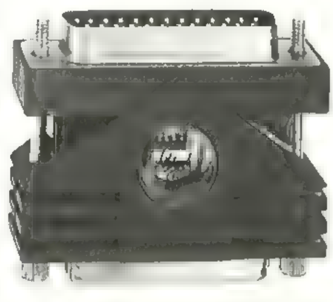

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executable. The premier exponents of this in the PC world are Clarion TopSpeed. In C, Pascal and other earlier languages smart-linking is a pleasant luxury as it allows you to use modules of source code as libraries. In C++, with its vast assemblages of overloaded functions, smart-linking is an important tool for generating compact efficient code.

The facility provided in this package is only a first cut at the problem. Microsoft have quite a way to go before this aspect of their tools fulfils its promise and becomes effectively transparent to the programmer.

As a C++ programmer with strong leaning towards object-orientation I am sorry to see that the compiler supports no more of C++ than MSC\C++ 7. I was staggered to find no less than 21 extra keywords (albeit correctly implemented with a leading double-underscore), 17 in the joint C/C++ list but without support for the new keywords introduced in June 1991. The implication is that this is intended as a compiler for compiling Windows apps. As such I believe it does a good job, but I have reservations about its suitability for other C++ programming tasks.

The combination of Compiler, Linker and debug support is an improvement on MSC/C++ 7 but not enough to merit a move from some other set of development tools.

The strengths of this product lie in the new tools: AppWizard, ClassWizard and AppStudio. When these are coupled with the much improved Microsoft Foundation Classes I must say that those developing applications solely for Windows need some very powerful reasons for not switching to MSVC++.

A major reason for staying with some other development package would be the desire to develop applications for other platforms. It is both the major strength and the major weakness of this product that it concerns itself with the needs of the Microsoft Windows application developer.

Benchmarks

The Editor was very keen that I provide some benchmark results. Unfortunately its main strengths cannot be assessed in these terms.

The complexity of modern compilers is such that actually getting optimal results from one is an art based on considerable experience (see the Dhrystone example). Every compiler producer can find benchmarks combined with compiler switches that make their product look good.

I took the batch of benchmark programs provided by *.EXE* and sent them to the UK product managers of MSVC++ and Borland C++ with the request that they return project files for each of the products that would provide the best results for their product. Both agreed that this was both a fair and sensible way to tackle the problem. Both companies sent me their 'white papers' on benchmarking. After more than four weeks neither company has managed to supply the project files. Instead, I have fallen back on using the default production optimisation switches.

What follows is a commentary on my results when compiling and running

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the various programs. They should give you some feel for differences between the two products. In fairness I think you should remember that Borland C++ 3.1 is almost a year older than MSVC++ 1.0.

You should also note that none of the programs was designed to exercise specific strengths and weaknesses of compilers. For example: no tests of the advantages of smart linking and of p-coding have been provided. On the other hand, programs that required facilities that are specific to the Borland product (or facilities not generally available, eg exceptions) have been omitted. A good example would be a C++ technique called 'smart pointers' that needs templates for an efficient implementation.

In the following both compilers were used to produce release versions of the executables for 386 machines. I ran both compilers from Windows with no other applications running at the same time.

Array. This is a simple program that creates a large array of longs, initialises it with a simple random number generator and then uses `qsort()` to sort it. This process is repeated 1000 times. MSVC++ took 21 secs to compile and link an executable of 12535 bytes of code that ran in 20 secs. BC++ compiled and linked in 8 secs producing an executable of 13580 bytes that ran in 16.5 secs. Recompiling for minimum size did little to affect any of the above figures.

Bisect. This is a little program whose source code is designed to give C programmers apoplexy; it contains five `goto` commands in 85 lines of code. It also lacks any form of documentation. If I understand correctly it is intended to check the accuracy of the floating point emulator.

MSVC++ took 22 secs to produce a 23318 byte executable compared with BC++'s 8 secs to produce a 23006 byte one. Both programs produced identical results (1.324718 compared with the programmer's claimed true result of 1.324707).

One interesting point is that MSVC++ managed to identify several lines of code that were unreachable. (Some test code that was conditionally executed if a debug variable was initialised as true. Yes, it was that sort of code.)

GNU awk for MS-DOS. This is a multi-file project that I used to test the compile and link speed (compilers set to produce minimum code size). I could not fairly benchmark the resulting executables because I had to do some rapid patches to get it to compile with MSVC++ and I cannot be certain that these did not alter some aspect of the product's functionality.

BC++ took 2 mins 58 secs to produce a 128972 byte executable from 108213 lines of source code. MSVC++ took 10 mins 45 secs to produce a 128649 byte executable from the same source code files.

GNU Chess for Windows. I used this to test MSVC++ compiling and linking with a make file for MSC\C++ 7. This is important if the package is to be used with existing products. It failed this test, generating two linker errors. Do not take this as a severe criticism,

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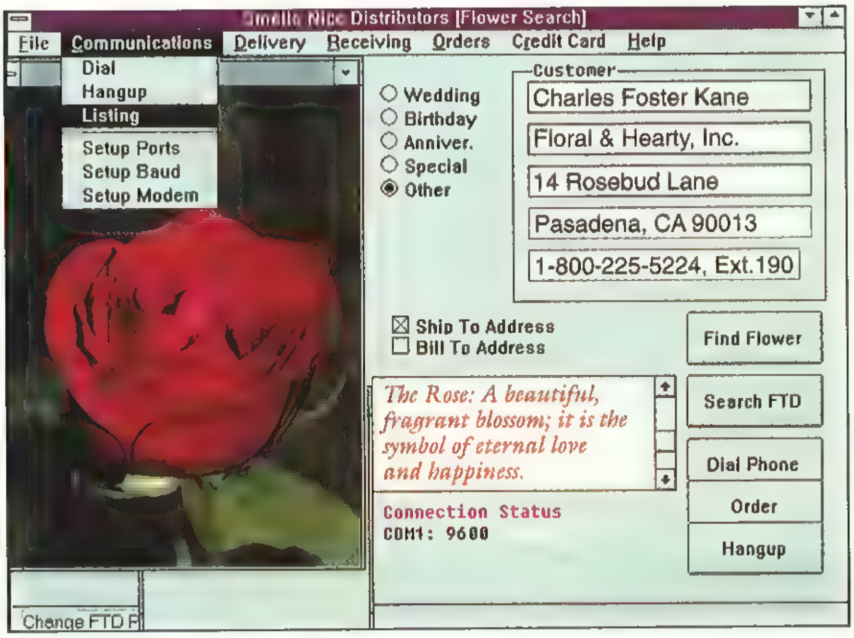

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but more as a warning that you may need to edit such files if you replace MSC\C++ with MSVC++.

Data Encryption Standard. This is a program that implements the DES in software. It is computationally intensive for integer arithmetic and I used it as a measure of MSVC++'s to optimise such code for speed.

MSVC++ produced an executable of 15535 bytes compared with BC++ which produced one of 19996 bytes. On testing these on a reasonably large file, the MSVC++ version was also significantly faster, 66 secs versus 77 secs.

Dhrystone. Now here we have an interesting set of results because this program is often used as a hardware benchmark. The results I obtained raise serious questions about using it to compare machines unless they can run the same executable.

BC++ took 13 secs to produce a 10488 byte executable that ran in 24 secs (=20833 dhrystones). MSVC++ took 27 secs to generate a 9569 byte executable that ran in 19 secs (=26315 dhrystones). I then noticed that the archive provided by *.EXE* included a 9466 byte executable produced by Microsoft using MSC\C++ 7. When I ran this I could hardly believe my eyes. It took 13 secs (=38461 dhrystones). There was also a make file provided, so I tried recompiling using MSVC++'s external make file facility. The result was different again, 9514 bytes running in 14 secs (=35714 dhrystones).

Nothing could have better confirmed my belief that benchmarking tells you more about the skills of the programmer than it does about compilers and hardware. Obviously the secret lies in the switch settings, but the hand tailored switches produced a smaller product that ran 50% faster than that produced by relying on the producers switch settings for fastest executable.

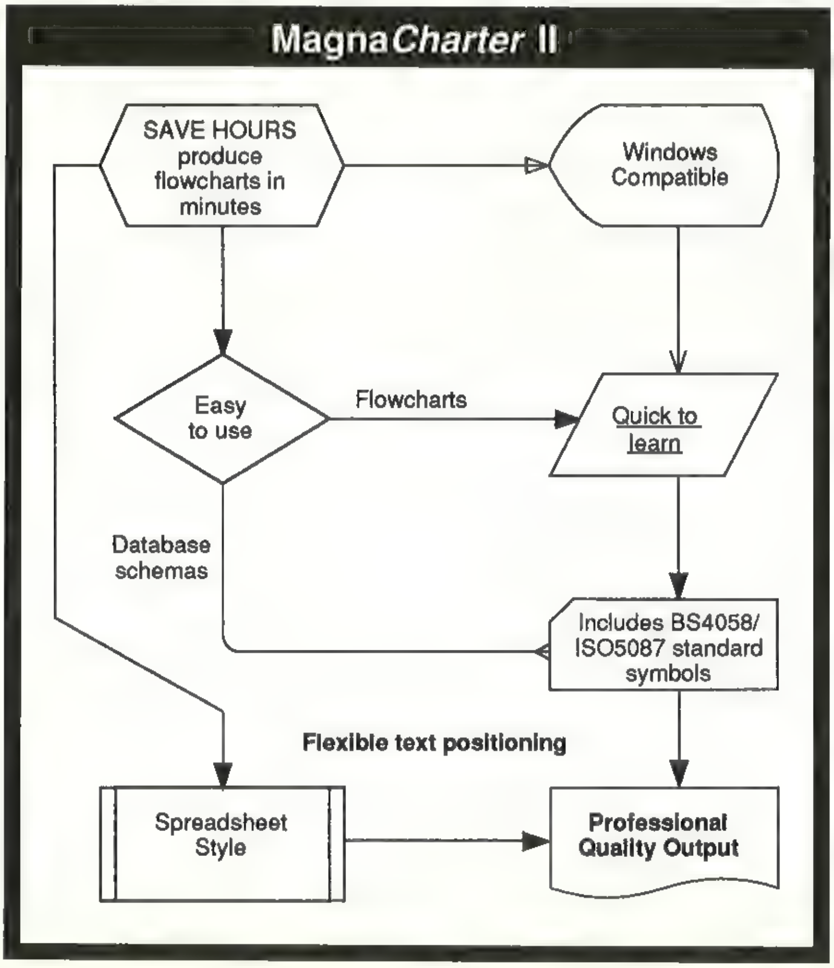
Conclusion

MSVC++ is a product that Microsoft can be justifiably proud of. There is still room for improvement, but I have no doubt that another one will be along next year. For those that it is aimed at (Microsoft Windows Application Developers) it is clearly ahead of the competition. The rest will either have to learn to program for Windows or use another compiler.

For those concerned with multi-platform development, MSVC++ produces fast compact code... slowly. It is not capable of using the newer C++ libraries that are based on the recent developments in the language except via ugly, error-prone work-arounds.

Francis Glassborow is the driving force behind CUG(UK), and Editor of its house journal C Vu. *For more information on this august organisation, please contact him on 0865 246490, or email francis@robinton.demon.co.uk.*

Microsoft Visual C++ has an RRP of £335 for the Professional Edition on CD-ROM or diskette, or £279 for a 'tree saver' version without printed documentation. The Standard Edition costs £139. Upgrade information is on 081 8938000.



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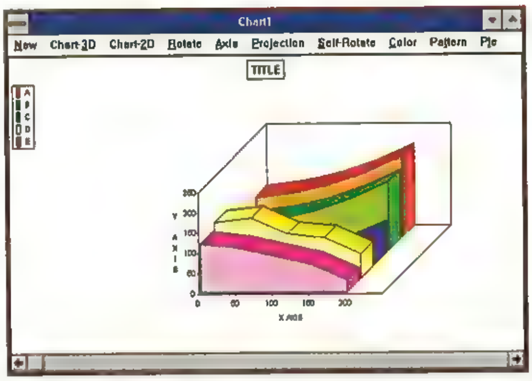
ToolsKan / VB



ToolsKan / VB is the latest piece of software from Kansmen Corporation - features include: Table control with input validation, split windows and colour customisation; 3D Chart with over 30 different 2D & 3D Chart styles, rotation and scrolling; Toolbox - create floating tool-palettes, creates buttons from bitmaps or text, supports scrolling, 3D buttons with colour customisation, single/multiple/no-state button groups; Ribbon/Icon Bar: add icon bars to application in a flash, supports combo-boxes, text and buttons; Field Validation for check date, time, number and custom 'Pic' fields; Meter Control - vertical, horizontal and circular gauges with a choice of needle or color bar as indicator; Status Bar with auto-scrolled text, stretchable field width, coloured progress bar, and show date/time/keystates. ToolsKan/VB is supplied as VBXs and is provided for Royalty free distribution with your programs.

Also available ToolsKan for C/C++/Pascal - supplied as DLLs, can be used with most applications that support custom controls.

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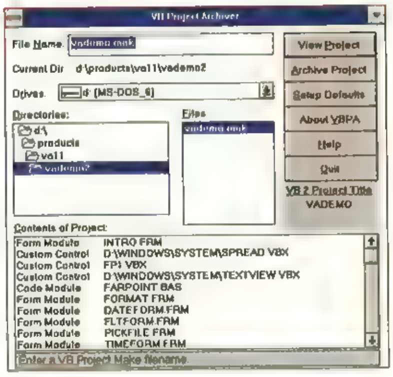
For Information Circle: 870

VB Project Archiver

Have you ever worked on a Visual basic project and found that the change you made didn't work, but had already saved over your previous version? Or, have you given (or sold) your program to others and realized that you left out a necessary DLL or VBX file? If so, you need VB Project Archiver!



VB Project Archiver is a utility for Visual Basic programmers, which allows the user to store all of the modules and files relating to the VB project in a single file using one of the popular archiving programs (PKZip, ARJ, LHA, ZOO and others), without leaving the comfort of the Windows Environment. VBPA uses the Makefile to get a list of modules and forms used in the project, so there is no need to worry about forgetting anything. VBPA will also scan the Global and Code modules for Declare statements for Windows DLLs or VBXs that might be used within the project! VBPA can even replace design-time Custom-controls with their run-time counterparts. *WHILE STOCKS LAST WHEN YOU BUY VBPA WE'LL GIVE YOU VB-TIDY - A NIFTY VB UTILITY.*

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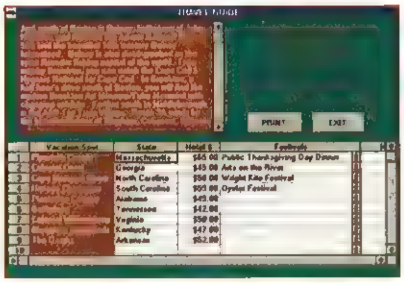
Visual Architect



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The 'True' spreadsheet control, makes Visual Architect stand out from any other software package. A major design goal was to make the spreadsheet extremely flexible and powerful. It can be used within your application as a functional spreadsheet - as a simple way of obtaining variable lines of data from the user - or as an easy way of displaying tables of information from a database.

Because of its unique flexibility, the spreadsheet can be customised for each individual user. It can optionally be locked so the user can't make changes. The width and height of columns and rows may be changed. The font, colour and data type may be changed for any row, column or cell. Cells can have the following data types: Edit, Date, Time, Integer, Float, Static, Formatted Picture, Combobox, Button and Picture.

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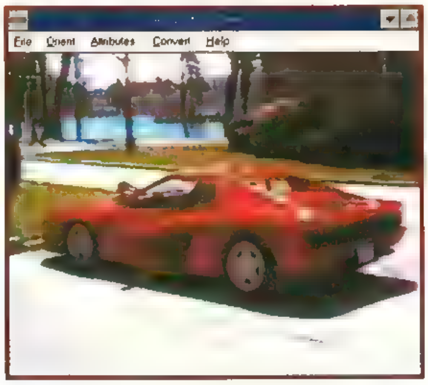
For Information Circle: 872

Image Format / VBX



Visual Basic and Visual C++ users can now add the power of imaging to applications without making a single function call! The Accusoft Image Format Library/VBX lets visual programmers add complete support for twelve raster file formats in less than 30 minutes! High-quality image display, with automatic support for panning and scrolling- It is so easy you'll be amazed! Zooming In and Out is as simple as setting a property. Also included are some image processing functions for modifiying brightness, contrast and sharpness.

The Accusoft Image Format Library/VBX uses several proprietary algorithms to maximize the display quality of all images - 24 bit images are colour quantized and colour smoothed for terrific results in 4 & 8 bit display modes. 8 bit images are displayed using colour dithering in 4 bit display modes to provide near 8 bit mode quality. All image processing functions are implemented as properties of the custom control - to invert an image, you would simply set the invert property to true. The library supports TIFF, PCX, JPEG, TGA, BMP, WMF, WPG, DIB, DCX, EPS, GIF and PICT. And of course there are no royalties!!

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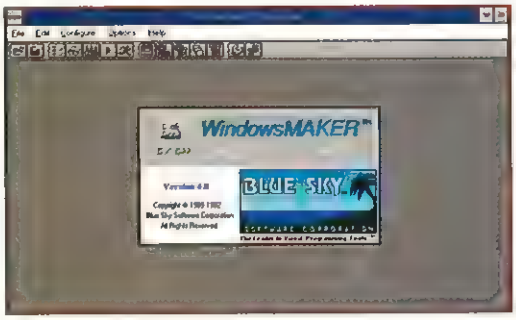
For Information Circle: 873

WindowsMAKER Pro



WindowsMAKER Pro is an object-oriented application C/C++ Code generator that builds complete Windows v3.X applications. Prototype the entire user interface (menus, dialog boxes, child windows, buttons, controls, etc.) in a point and click WYSIWYG screen designer. Animate the user interface to instantly test the look and feel of your program without a lengthy compile, then generate C source code with all the necessary production files to make a complete Windows application. Any added custom code is preserved during code regeneration. WindowsMAKER Professional handles message processing, memory management, debugging, compiler settings, MDI and more. WindowsMAKER generates excellent quality C code, and with the optional Switch-It modules you can also generate C++. All the generated code is highly documented, so hand-modification is easy. It can also help you move DOS or Mac programs to Windwso in record time. WindowMAKER Pro is invaluable to anyone writing in C. All code generated is royalty free.

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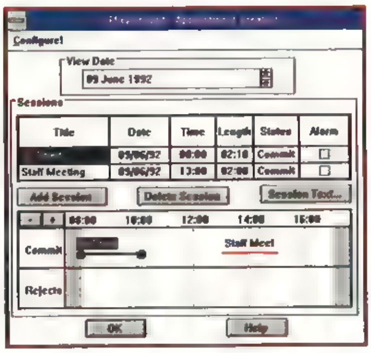
For Information Circle: 874

Out of Controls



Out of Controls is a set of 5 Custom controls for use within Windows. The controls include: Spin Box Control with full function edit box, spin selected or default field, date, time, numeric or custom styles; Modal Spawning Library for opening DOS/Windows and not returning control to the main program until the spawned application has terminated; Multi-Cell List Box includes check box, radio buttons and editable text cells, rows may contain multiple cells of any type, automatically scrolls vertically and horizontally, allows rows to be reordered by drag and drop; Text Editor Library adds an editor to an application in second. Provides file, print, edit, clipboard and search options. Supports files up to 32k in size; Line Object Editor in which each object may be configured as either mixed or movable against the ruler, as fixed size, resizeable or split and rejoinable. Allows mutliple category rows for sorting objects and also supports customised ruler formats.

Out of Controls comes complete with 150+ page manual and examples. Source Code available.

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Dyad M++

M++ provides a complete multi-dimensional (up to 4 dimensions) array language extension to C++. M++ includes both LINPACK linear system classes and EISPACK eigensystem classes and allows the user to perform array manipulations, numeric operations on arrays and sub-arrays, as easily as on scalars. An important feature of M++ is the ease with which users of APL, MATLIB, GAUSS and array languages can quickly write code in a similar array program style. The M++ Class Library provides methods and functions for array, matrix and vector manipulations as well as a full complement of linear system and eigensystem analysis classes. M++ enables the solution of most difficult array handling or advanced scientific programming problems quickly and easily without sacrificing algorithmic control or program performance. M++ release 4.0 provides additional array types (BitArray and PointerArray) with an expanded set of functions and methods including FFTs and convolutions for float, double and complex arrays. FFTs can be performed on vectors or arrays of vectors as well as performing multi-dimensional FFTs. Likewise convolutions can be performed on vectors or matrices.

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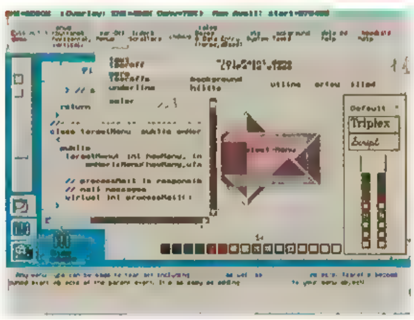
object Menu v2

object-Menu v2.0 provides an object-oriented architectural framework for your application. The intuitive architecture and natural programming syntax increase your productivity more than you ever thought possible. Seamlessly port your product between DOS graphics and MS-Windows using the interface objects. Give your Windows applications a facelift: the library includes extensive icon capability and optional Motif-Styling not found in other Windows API's. Create your own objects easily by extending our class library. object-Menu includes windows, icons, scroll bars, menus, buttons, toolbars, dialog boxes, data entry, spin control, file chooser, comboboxes, justified page display with embedded icons and hypertext primitives, and much more. Special features: dynamically change scroll bar resolution, multiple line items, multiple icons for a menu item, several menu styling and item selection options, compact, natural programming syntax. Special DOS features include help and icon libraries, hypertext help system, event management and an overlapped window manager.



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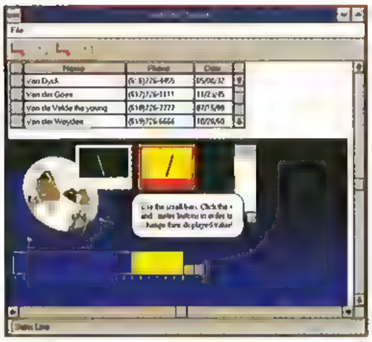
For Information Circle: 877

Diamond Toolbox



Diamond Toolbox is seven packages in one: Cockpit, Revision Control, LoadIt, HelpIt, Field Validation, Gadget Library together with the actual toolkit and source code.

Using Cockpit, the advanced workbench and revision control system, you are only three clicks away from your first Windows Application. Cockpit handles resource, make, include, definition and source files. You only have to deal with the functions and projects. LoadIt is a powerful installer that requires no compilations for generating setup configurations. LoadIt supports dialog boxes, bitmaps, background fountain fills. HelpIt is a lightning speed help interpreter - using the hypertext style programming language you can create on-line help on the fly. Field Validation uses COBOL-like patterns, real time validation, range checking, large number of data types such as money, text, date, time, and with international support it is the most powerful data entry package on the market. Smart Objects can be moved, resized, modified, enabled, disabled, removed and their relative position (front/back) changed. Objects include balloon help, meters, gauges, spreadsheets, etc

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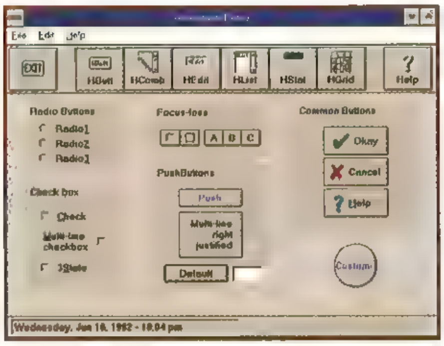
WinWidgets



WinWidgets is a set of custom controls for Windows. Features include Edit Control, List box, Combo box, Cycle Box with smart edit masks for data validation hot-linking to program variables; Button Control - display text and/or bitmaps, animate different button states, play sounds, also checkbox and radiobutton styles; Status Bar, Ribbon Bar and Floating Palette enable the user to create a great looking professional user interface - it can be attached to a window side or float above; Modeless Forms - design like a dialog box but it can be displayed in any window; Optional Grid control for easy use with databases, add records in a single statement, edit and list fields, browse mode, edit in place of spreadsheet style, resizeable rows and columns, cut & paste to and from the spreadsheet. Supports ODBC and SQL Datatypes.

Source code is available - WinWidgets is Royalty free.

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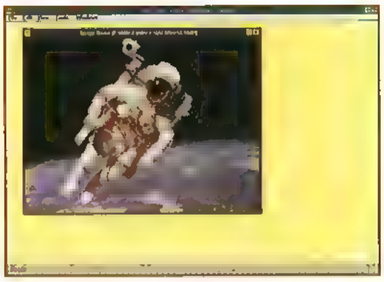
For Information Circle: 879

Image SDK Plus



The New Image SDK Plus has arrived!! Read/Write/Print TIFF, PCX, GIF, TARGA, MS-Metafile, Clipboard, DIB and ColorFax Format. Image transformation: Antialiasing conversion, scaling colour images, bilinear or cubic spline interpolation, skew image for OCR, rotation in 1 degree increments, dithering, display DIB or DDB image, compress and decompress DIB, scrolling, utility functions, digitize ASCII text. Also available from Black Ice - New TIFF SDK for Windows v4. Features include: New High Speed Group 3 and Group 4 fax formats, IBM's MMR IOCA, decompress from memory, decompress from every repaint, LZW and Packbit compression, 24 bit colour images, chained images. Contains over 50 functions. (£249)

Both packages are supplied compete with manuals and example code - No royalties. Image SDK Plus and TIFF SDK for Windows work with Borland C++, Microsoft C and Visual Basic.

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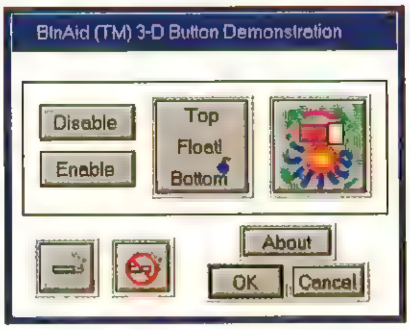
ButtonAid enables the programmer to create great looking 3D Effect buttons without much additional programming. Commands to ButtonAid's DLL are placed in the buttons' caption text, and are processed at runtime.

Features include: Text, bitmap and text & bitmap buttons.

ButtonAid requires Microsoft C or Borland C++ for Windows.



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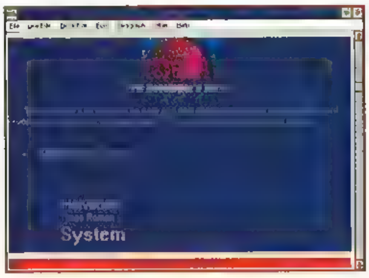
TE Developer's Kit



Incorporate text editing features into your application easily and cost effectively. Features include: multiple files and windows, word-wrap, edit large files, reconfigurable keyboard and screen colours, undo, cut/paste, print, search/replace, word processing features such as WYSIWYG, indentation, double spacing, centering and right justification, imbedded pictures, multiple fonts and sizes. The kit also includes TER small editor routine - a subset of TE. Your application calls this routine by specifying the window location and size, maximum file size and an input buffer or file. Includes the complete 'C' source code.

TE Developer's Kit v3.5 is available for DOS, Windows, OS/2 PM. Also available is Spell Time a full featured spell checker that can interface with TE if required; ChartPro a charting DLL that can draw 3D bar, pie, line/area and hilo graphs; Report Ease a form layout editor and report executor.

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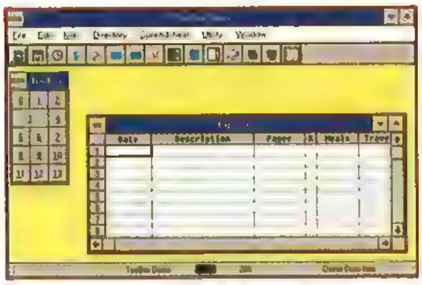
Drovers Toolbox v3



With 23 custom controls, including FarPoints industry unique full-featured spreadsheet control (not a grid!), Formatted Editor Controls, Tool Bar and Status Bar, ability to add 3D effects to dialog boxes, View Pictures with animation, and Enhanced Listbox this package is a developer's dream come true!

Over 300 functions are built in, including DOS System functions, Data/Time support, String Functions and Enhanced file support.

Drovers Professional Toolbox supports MSC 7.0, Borland C++, Turbo Pascal, Actor, WindowsMaker Pro, Borland Resource Workshop and Dialog Editor. Drover's Professional Toolbox for Windows does not require any Royalty payments.

Users of Drover's v2 - v3 upgrades are now available please contact us for more details.

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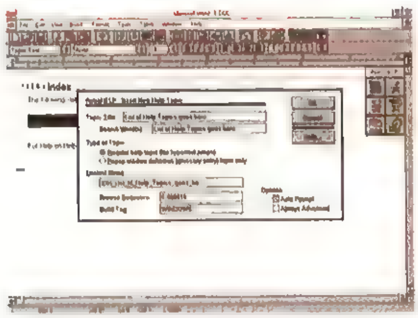

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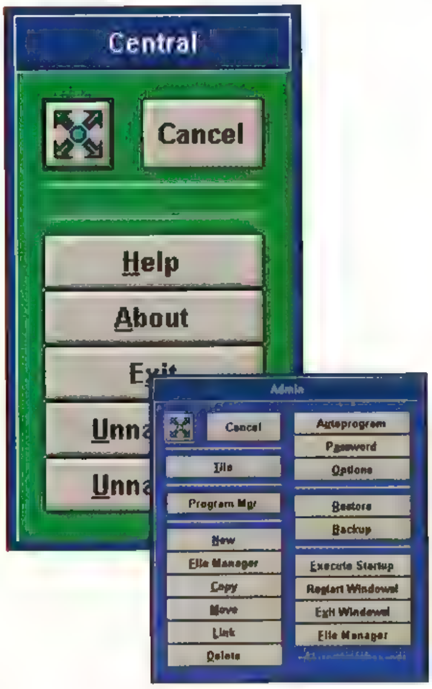

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Practical TCP/IP

After last month's tour of Internet, Laine decided he should explain some of the protocols that make it work, and tell you where to get source code implementing the protocols.

When I started writing this article, my objective was simply to show, in C++ code, how to write a program that communicated with another machine on the Internet using the TCP/IP 'Telnet' virtual terminal protocol. As I got further and further into the explanation, I realised that, without knowing some lower level details of TCP/IP itself, although you would be able to type in the code and run it, you might not understand what was happening when you did so. By the time even the most essential explanations were finished, my space was nearly filled. I then decided that, rather than trying to short change you on low-down details just to fit everything in, I should rather fill in some of the blank spots in this general explanation of TCP/IP, and save the Telnet program for next month (in the meantime, augmenting it with implementations of a few other useful TCP/IP utilities).

Basic TCP/IP

We all know that the Internet is based on 'TCP/IP'. But just what does that mean? TCP/IP is *not* a program (just like the Internet is *not* a network). It also is *not* a protocol. Rather, it is a suite of protocols, the most important of these being TCP and IP.

TCP stands for 'Transmission Control Protocol'. A TCP packet contains information about which session of which protocol (or, in simpler terms, which process on the remote host) the packet's data is intended for. A TCP sender must hand an outgoing packet to IP (see below) and wait for the acknowledgement (ACK) from the other side, retransmitting if the packet is damaged or not received. The TCP receiver is responsible for checking the integrity of the received data packet, sending an acknowledgement back to the sender, sequencing this packet relative to other received packets, and delivering the data to the proper process. TCP also handles flow control, to make sure that a process on one host does not swamp another. In summary, TCP handles the end-points of a full duplex, reliable data stream, knowing nothing about what happens in between.

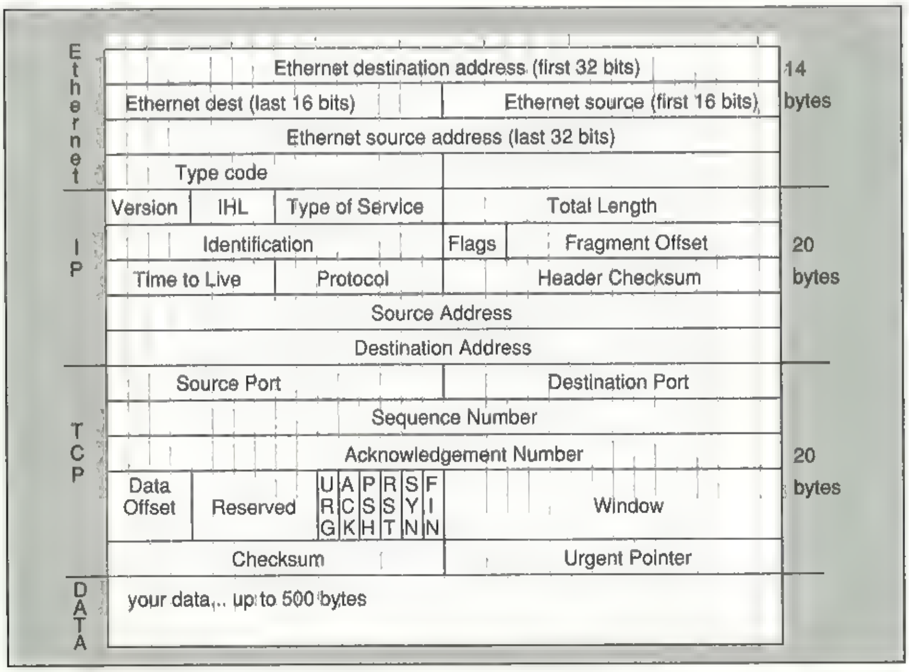

*Figure 1 -
A TCP Packet inside an IP Packet inside an Ethernet Packet*

IP

TCP does all its sending and receiving using IP ('Internet Protocol'). IP makes no attempts at interpreting the meaning of the data in the TCP (or other kinds of) packets, or even checking the integrity of the packets. It is only concerned with getting these packets from the source host to the destination host. All routing of packets to help them find their way through the heterogeneous jungle of Ethernets, modems, T1 data lines and whatever is handled by IP (and some sibling protocols). IP does its routing using 'IP Addresses' (discussed last month). Each IP packet header contains the source and destination IP addresses. It also contains a 'Protocol' field, which is set to '6' for TCP packets.

Note that, although IP does a checksum to verify the integrity of the IP header, it makes no attempt at validating the data in the packet - as that is done by TCP anyway, it would just be a waste of CPU time. IP is what is sometimes called a Datagram service. It makes a best effort attempt to deliver packets, but does not verify or guarantee their delivery, and rather obviously cannot automatically retransmit damaged or lost packets. That's up to the higher level protocol (TCP in our case).

Although in practice these two protocols are implemented together, the conceptual division helps immensely when trying to understand how it all works.

Wrapping and Tunnelling

While connections between nets are usually done with some kind of point-to-point link (modem, ISDN), the most common form of local net is Ethernet, and Ethernet has its own packet format. Rather than stripping off the IP header (which would be disastrous if the destination was not on the local net!), the entire packet, header and all is wrapped up in an Ethernet packet. Therefore, when your program sends

out a TCP packet to a program on some remote system, what is really sent is a TCP packet, encapsulated in an IP packet, encapsulated in an Ethernet packet. Figure 1 shows what the resulting conglomeration looks like.

Something similar happens when you send IP over X.25, IPX (Novell), Arcnet, or any other protocol (whether hardware or software imposed). This practice of sending one protocol wrapped inside another is sometimes called 'tunnelling', and is the key to TCP/IP's connectability. IP packets contain no hardware layer specific information, meaning that an IP packet can travel anywhere, on any media (even by surface post on a magnetic tape, if you are masochistic and set some *reeallly* long time-outs).

Address Resolution

An interesting note concerning the sending of IP over Ethernet is that IP likes to send packets to an IP address (an abstract number, not based on anything worldly except the manager who assigned it) (however worldly *that* may be), but Ethernet cards want to send the packet to an Ethernet address (a concrete number, hardwired into the Ethernet card when it is manufactured). Although it is possible to send special 'broadcast' packets on Ethernet, doing so for all packets would force every machine to examine every packet, causing great load on the machines, especially PCs. To make the net run efficiently, we must determine the Ethernet address for a given IP address before we can send an IP packet over Ethernet.

Another protocol, ARP (Address Resolution Protocol) comes to the rescue here. ARP is at the same level as IP (ie, *not* encapsulated in IP, as is TCP). In simple terms, when it becomes necessary to send an IP packet to a previously unencountered IP address, ARP sends out a single broadcast message to the local net, asking 'Which one of you has IP address n.n.n.n?' The machine with that IP address responds 'I have that IP address, and my hardware address is h:h:h:h:h:h' (Ethernet addresses are 48 bits.) In the case that the host with the IP address in question is not on the local net, a router connected to the net must 'lie' and claim that it has IP address n.n.n.n. In either case, subsequent IP packets will be sent to the given Ethernet address, either directly to the remote host, or to the router for forwarding to another net. Aside from an occasional ARP broadcast, each machine on the net will receive only its own packets.

ARP, by the way, is also usually implemented as part of the TCP+IP library. In particular, it is tightly intertwined with IP.

Port	Protocol	
7	ECHO	
13	DAYTIME	
17	QUOTE	(quote of the day)
20	FTP-DATA	
21	FTP	
23	TELNET	
25	SMTP	(Simple Mail Transfer)
53	DOMAIN	(Domain Name Server)
79	FINGER	
111	SUNRPC	(Remote Procedure Call)
119	NNTP	(NetNews Transfer)

Figure 2 - Some well known TCP Port numbers

TCP Details

After giving an overview of how the packets get from one host to another (IP + ARP), let's forget about that, and assume that all TCP packets created on one host magically appear on the other. Most of the time. What is inside these packets, and how are they interpreted?

A look at the packet diagram (Figure 1) shows that each TCP packet has a 'source port' and a 'destination port'. In combination with the IP addresses of the source and destination (from the IP header), these two ports determine both which protocol the packet is for, and which process it is going to. I say 'combination' because the interpretation changes based on which side of the connection we are.

TCP protocols are all based on the concept of client and server. A server 'passively' listens for a connection using a particular well known port number (eg 23 - the port number for Telnet) as the source port. A client can then 'actively' open the connection using the well known port as destination, and some other currently unused port as source. After opening, incoming packets on either end are given to the proper processes by checking the 'source IP+port/destination IP+port' pair, which is guaranteed to be unique for any connection. The result is that server processes can listen on standard port numbers for standard protocols, while multiple connections using the same protocol can be made simultaneously to the same host without danger of ambiguity.

Several ports (protocols) have been defined for TCP - Telnet, FTP, SMTP (Simple Mail Transfer Protocol). Figure 2 shows a list of some 'well known' TCP port numbers. Remember, this number is the number the server listens for as, and the client sends as, 'destination port'. The source port (in packets from the client) can be any other number.

Although different protocols use different port numbers, the method of reading and writing the data is the same for all. Only the interpretation of said data changes.

Once a TCP connection is open, the data bytes of the packets can be treated as a reliable stream of bytes, sort of like a sequential file. No record length or other structure is placed on the data by TCP itself, and there is no guarantee that data will arrive in chunks of a certain size. However, you are guaranteed that the 201st byte will be delivered to your application before the 202nd byte, and that every received byte is correct.

BSD Sockets

To make reading and writing data on TCP connections easier for application programmers, the designers of BSD Unix created a concept called *sockets*. A TCP socket is (just as an electrical socket is) a connection to the rest of the network - in particular, to the process on the remote host.

In BSD, a socket is opened with a special function, `socket()`, which returns a descriptor number similar to that returned by the file `open()` function. After opening the socket, it must be bound to a particular source port by calling the `bind()` function. To complete the opening process and establish the connection, the server waits passively with `accept()`, while the client actively attempts the connection with `connect()`.

Although there are special functions available for reading and writing to open sockets, it can also be done with the same library functions that read and write files. Closing a socket is also accomplished with the standard Unix `close()` function. (Internally, these

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functions determine whether to do socket I/O or disk I/O according to the descriptor number.)

BSD can combine the TCP and file functions in this way because TCP/IP is built into the BSD kernel - it's always there. Us humble folks trying to write programs for DOS don't have this level of consistency - DOS comes from one vendor, the compiler (and its library) comes from another, and the TCP/IP library from yet a third.

TCP/IP for DOS

Even before Bilkent was connected to the Internet, I was curious about TCP/IP. I wanted to write comms programs using TCP/IP, but didn't have the time (or the desire) to implement the entire suite from scratch. Looking around for ready-made libraries, I only saw expensive packages (sometimes so expensive that they were afraid to quote a price in the ad) of questionable clarity (beware of an ad for software that says 'consulting services available').

During the last few months of our BITNET era, I managed to find a few 'free' TCP/IP implementations for DOS via ftpmail, and just recently found yet another with anonymous ftp. For those who are anxious to dig into source code, the most interesting were:

```
// (note - s param is actually tcp_Socket *)

// for opening a tcp socket
int tcp_open(void *s, word lport,
             longword ina,
             word port,
             int (*datahandler)());
tcp_listen(void *s, word lport,
           longword ina,
           word port, int (*datahandler)(),
           word timeout);
int tcp_established(void *s);

// reading from a socket
word sock_dataready(void *s);
sock_read(void *s, byte *dp, int len);
sock_fastread(void *s, byte *dp, int len);
word sock_gets(void *s, byte *dp, int n);
byte sock_getc(void *s );
sock_scanf(void *s, char *format, ...);

// writing to a socket
sock_write(void *s, byte *dp, int len);
void sock_enqueue(void *s, byte *dp,
                  int len),
sock_fastwrite(void *s, byte *dp, int len );
sock_puts(void *s, byte *dp);
byte sock_putc(void *s, byte c);
sock_printf(void *s, char *format, ...);

// other control/status/etc
sock_flush(void *s);
sock_flushnext(void *s);
sock_close(void *s);
sock_abort(void *s);
sock_mode(void *s, word mode);
sock_wait_established(s, seconds, fn,
                      statusptr);
sock_wait_input(s, seconds, fn , statusptr);
sock_tick(s, statusptr);
sock_wait_closed(s, seconds, fn, statusptr);
```

Figure 3 - List of WATTCP functions

KA9Q

This package was written by Phil Karn (Ham callsign KA9Q) primarily to allow ham radio operators to network their computers via shortwave radio using a special type of 'broadcast modem' (the best term I can think of).

TCP/IP is not a program (just like the Internet is not a network). It also is not a protocol

KA9Q also includes hardware interface modules for serial port (SLIP and PPP), Ethernet, and generic packet drivers (a hardware independent interface for network software). KA9Q contains a full TCP/IP implementation with integrated applications for most of the popular protocols: telnet, ftp, smtp, etc. The C source code for the entire package is available, although the documents say that it is freely usable only for radio amateurs and academic institutions. I haven't looked at much of the code, but it can't be too bad, as Phil Karn even has a TCP-related algorithm named after him. Although there may be a more recent version somewhere else, I got the KA9Q source code from oak.oakland.edu: pub/msdos/ka9q-tcpip/s920603.zip (the number is a date, so it may change).

Aside from distribution restrictions, my main problem with KA9Q was that it was written as a single, self-contained program. Although I didn't investigate deeply, the application side of the protocols seemed too tightly integrated with the protocols themselves. On the other hand, KA9Q has IP routing built in to its kernel - a PC running KA9Q makes a quite serviceable (although a bit slow under load) TCP/IP router.

NCSA Telnet

This is a Telnet application plus several other TCP type applications written by folks at the National Center for Supercomputing Applications. Full source code, in C, is freely available to anyone who wants it. There are no restrictions on use, redistribution, even copyrighting and sale of the programs or their source. You can find these files in several places, but a good one is dorm.rutgers.edu: pub/msdos/NCSA_Telnet/msdos/tel2306s.zip.

Again, reading the documentation gave me the feeling that the TCP/IP functions were written first with the idea of supporting the NCSA Telnet program, not as a stand-alone, generic TCP/IP function library. There was also some confusion in the organisation. Although there were `netxxx()` functions (low level) and `Sxxxx()` functions (session level), it wasn't really clear when to use which. Sometimes suggestions were made to use functions from the two levels in combination with each other.

Waterloo TCP

This is the library I chose, for several reasons. First, it was designed not as a part of a single application, but to be used as a general purpose library for any TCP application. Second, it seemed to me to be the best organised (externally at least), using a socket paradigm similar to BSD. Most of the function calls can be directly mapped into an appropriate C++ class or two. Third, although there are restrictions on distributing modified forms of the library, or selling the library itself for a profit, you can freely distribute the library unmodified, and sell derived applications for a profit. The original library is available from dorm.rutgers.edu: pub/msdos/wattcp/wattcp.zip.

Figure 3 shows a list of the socket related functions in WATTCP. Note that most of them are related to either reading or writing a socket. As the only thing changing from one protocol to another is the port number and the interpretation of the data stream, not much is left for the application programmer to do (ha ha).

Included with WATTCP are the source code for several standard TCP/IP applications, including FINGER, PING, LPR, LPQ, COOKIE, and several others. There is even a program that installs a telnet client over the INT 14h serial port interrupt, allowing you to use a standard serial comms program for telnet. Perusing these programs will

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teach you a lot about WATTCP, but if you really want to get the lowdown, you can order a reference book directly from the author (he swears he'll only use the money to improve WATTCP) - details in the doc files.

Trying it out

You don't need to be connected to the Internet to run WATTCP programs. WATTCP uses the 'Packet Driver' interface to communicate with the network hardware. (A packet driver uses a set of standardised interrupt calls to send and receive packets on vastly diverse types of hardware.) If you aren't fortunate enough to have a network lying around, you can easily set one up by connecting two PCs with a null modem cable and install a SLIP (Serial Line Internet Protocol) driver on each. The proper driver, and batch files to start up this simple TCP/IP network, are included on this month's disk (or on firat.bcc.bilkent.edu.tr in pub/Local/Cplusplus/simplenet.zip).

Even if you already have a TCP/IP network set up, you'll still have to load a packet driver to run WATTCP derived programs. Drivers for nearly every piece of communications hardware ever invented can be found on

Always be wary of an advertisement for software that says 'consulting services available'

oak.oakland.edu: pub/msdos/pktdrvr/drivers.zip (Watch out! This file is over 300 KB!)

Now, where did I put that Ronco Pocket Classmatic? Gotta churn these socket classes out...

(To be continued)

EXE

Bibliography *Comer, Douglas E.:* Internetworking with TCP/IP *Volumes I & II, Prentice Hall, 1991 ISBN 0-13-474321-0.*

Hedrick, Charles: Introduction to the Internet Protocols, *available on oak.oakland.edu in pub/msdos/ka9q-tcpip/ka9qbgn.zip, file tutorial.txt.*

Although he has taught C++ and OOP at Bilkent University for the last three years, by the time you read this Laine will have given his last exam. He and family (== wife + cat) will be departing for destination unknown in the near future, but the magic of mail forwarding should keep his email address valid: laine@firat.bcc.bilkent.edu.tr.

Much of Laine's code is available by anonymous ftp from the same address in directory pub/Local/Cplusplus. Log in as user 'ftp' and give your email address as password. For the Internetly challenged, Laine's bits and pieces are also available for free on disk, provided you follow the rules given in column 1 of the Contents page. Mark your envelope 'TCP/IP' to obtain this month's material.

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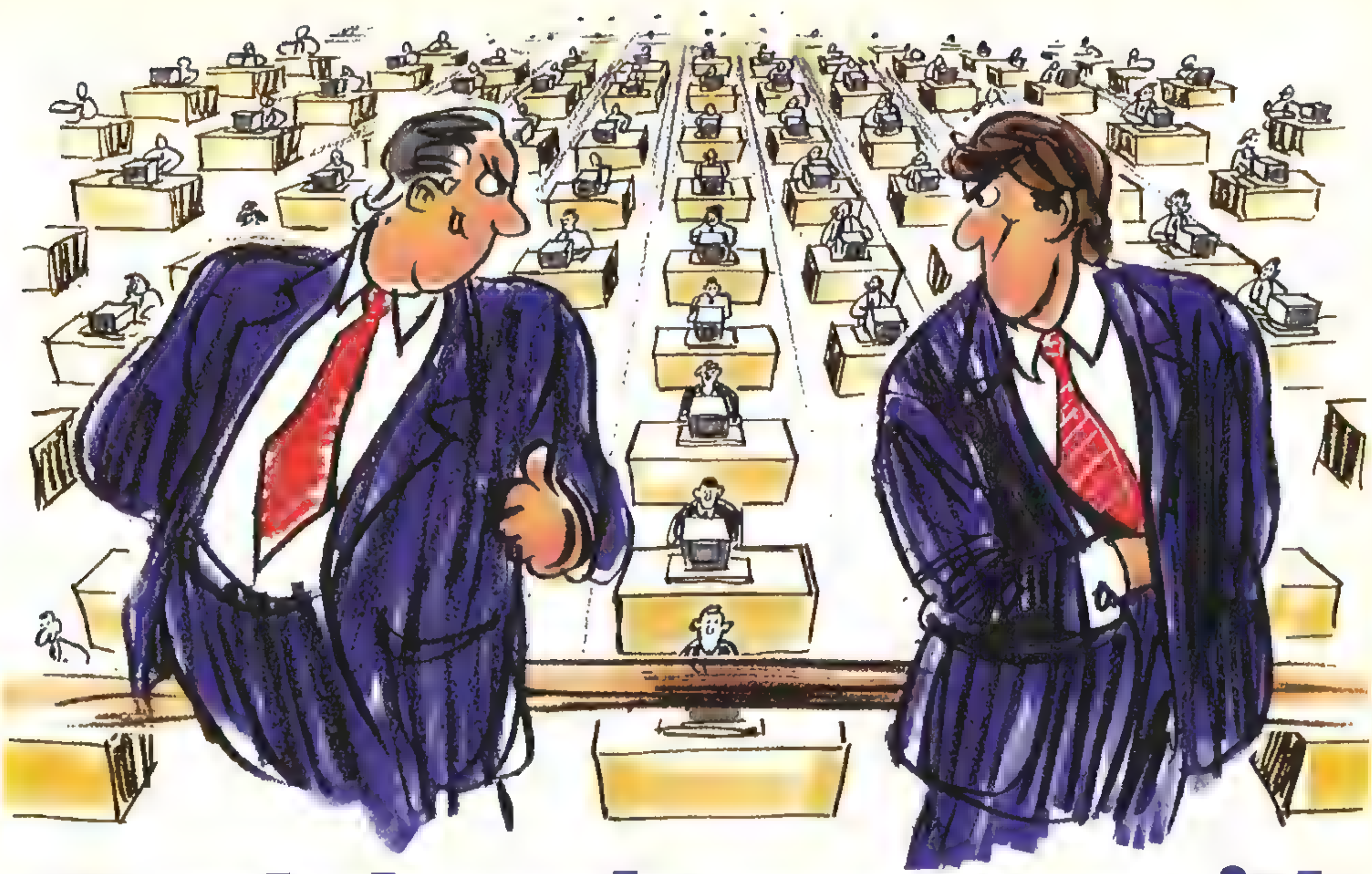

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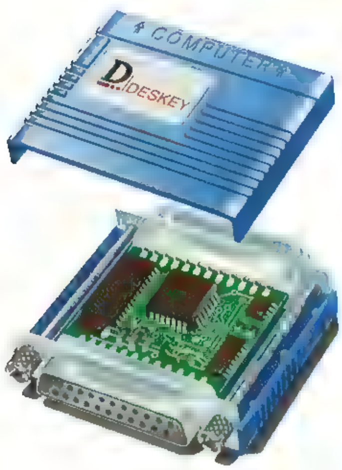

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TFN '93

Jules has been telephoning all kinds of people, researching for the worst award in the business.

Although it's a very unfashionable view, I have to say I have very little sympathy with FAST and its ilk. FAST would have us believe that the customers of software products are queuing up to steal the publishers' hard-earned, and the poor publishers need all the protection that can be legislated. It's rubbish, and it's clearly rubbish, as the thousands of shareware suppliers who earn good livings and, in some cases, small fortunes, stand witness.

To some extent, the problem is caused by the suppliers themselves. Not even the sorriest hacker will boast about using PubliCad without having paid a $40 registration, but to boast that they have completely undongled MegaCad, and it's no better, but you can have it for what it's worth instead of $5000 - aye, there's something to be proud of!

They're proud because they, like me, and like the shareware publishers, think that MegaCad is overpriced. What do you get for your money? You get the disks, of course, along with all the brain power that went into recording them; you get the printed manuals, you may get a little piece of plastic that fits nicely over the function keys until it disappears behind the filing cabinet, and you may get a little reference card that does its job quite nicely until it is pressed into service as a fly-swatter. People can copy disks, of course, and if they're really determined they can photocopy the manual, but if someone is prepared to waste a day at the photocopier, they probably wouldn't be able to justify a copy of the program.

But most of all, the thing that no sensible user would consider operating his software or hardware without, is the technical support. The users can't copy this. They have to subscribe. The only sensible way to select a software package, after 'will it do the job?' is 'will it go on doing the job?' Forget the myriad features, the user-friendly keystrokes, or the pretty graphics; if the software can break taking live data with it, you have to have some kind of support. What a user is buying into is not clever programming or complex maths, he is buying a tool that will solve his problems for him.

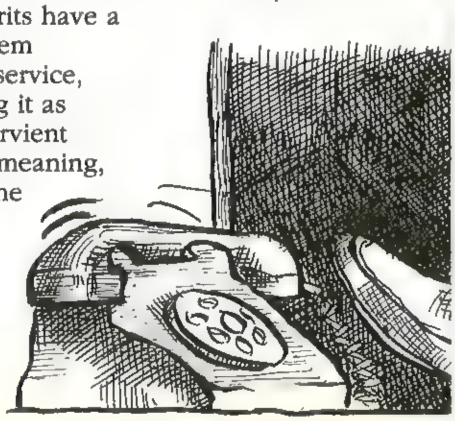
Now we're part of Europe (if that's what we are) poor support will not do - we will lose business because of it

This is why shareware works. These people are no less professional than the big companies, though they operate at a smaller scale. Their programs tend to be more compact, and therefore more reliable, and when you phone them, you know you're talking to the people who understand the software; you know they'll get it fixed if they're still in business twelve months after they've released their product, and there's a good chance they'll still be at their desks at 9pm. Shareware tech support is either non-existent or excellent.

Would that the same could be said about the larger companies! MegaCad (use your imagination) refused to give me any technical support whatever, because the version of its software I was running happened to be American, even though it was supplied to me by the UK office. Microsoft told me, after four weeks of describing a fault to them, 'Yes, it's a bug. Don't do whatever causes the bug to be expressed'. And it is totally unacceptable for a support line to say, as one did two weeks ago of a fault which repeatedly and repeatably shut down the entire system, 'We have no ideas. If you figure it out, be sure to let us know'.

Technical support is part of the product - indeed, it is where most of the perceived value lies. To supply a product and then refuse to support it effectively is fraudulent. To charge stupid prices for software that doesn't work, and then complain that people are poking inside it because the publisher refuses to fix it is childish. This is why this year's award goes to support lines.

I have a feeling that, in the UK, we get particularly bad support. The best support seems to come from the US and France, and the worst (and rudest) support I have ever had has been from British and German companies. When we were an island, that didn't matter too much - we just gritted our collective teeth and put up with it, but now we're part of Europe (if that's what we are) it will not do - we will lose business because of it. Frankly I think the Brits have a problem with service, seeing it as subservient or demeaning, and the



countries which don't have these hang-ups seem to produce better salesmen, more comprehensible experts, and of course more effective tech support.

So, without any apology, I'm making both awards to British companies. The runners-up award goes to Ashmount Research, creator of Off Line Readers (OLRs) for various email systems. Although it makes good products, which work very well most of the time, Ashmount's support is dreadful. Over a period of two months, the company replied to email late (if at all), it answered its phone only once ('They're all out. Don't know when they'll be back'), never once returned a call, and finally came up with the 'No ideas' gem I gave earlier. That just doesn't cut the mustard, and I reckon the company has lost sales because of it.

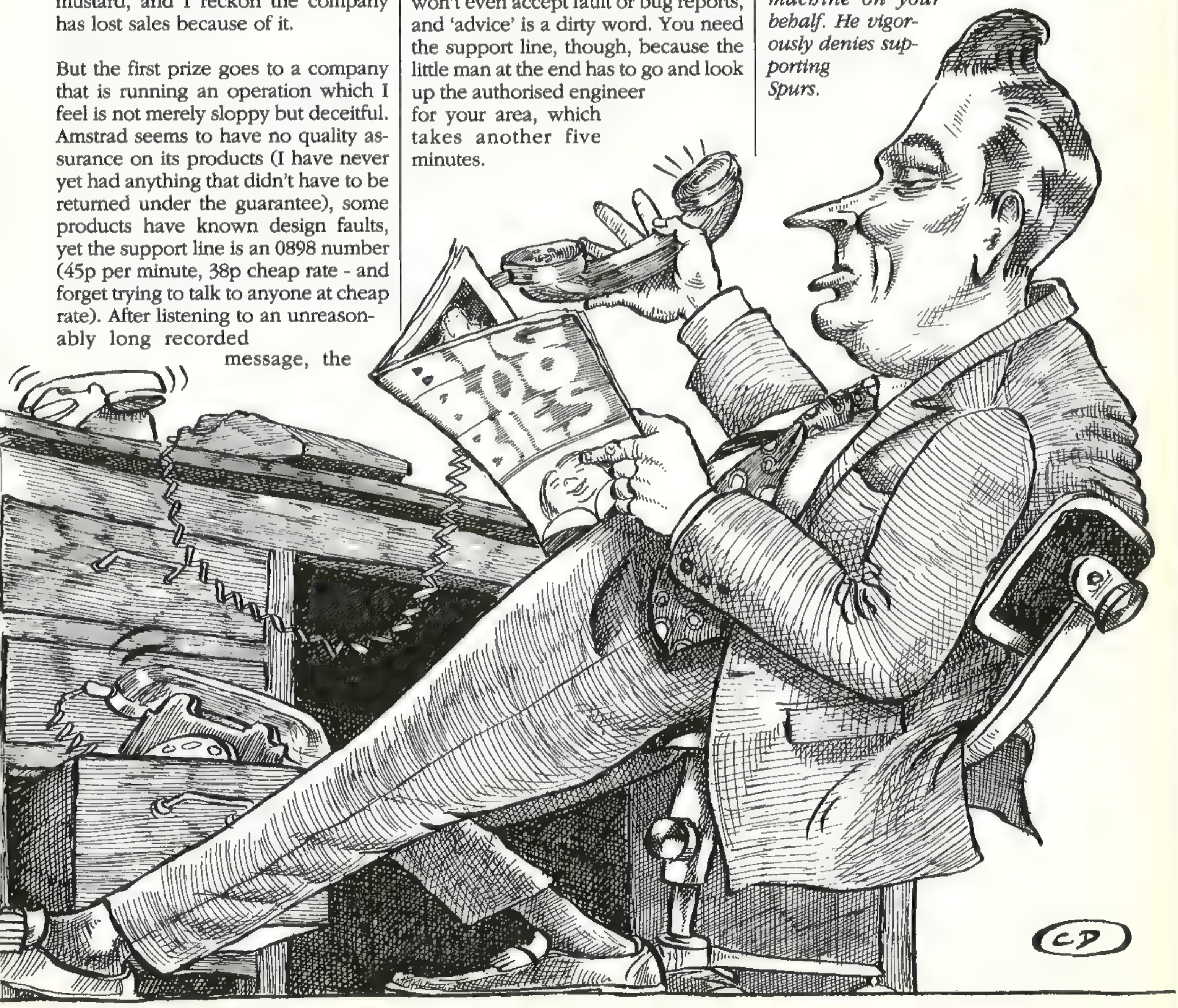
But the first prize goes to a company that is running an operation which I feel is not merely sloppy but deceitful. Amstrad seems to have no quality assurance on its products (I have never yet had anything that didn't have to be returned under the guarantee), some products have known design faults, yet the support line is an 0898 number (45p per minute, 38p cheap rate - and forget trying to talk to anyone at cheap rate). After listening to an unreasonably long recorded message, the only suggestion I have ever had is to contact one of Amstrad's authorised engineers. It doesn't sell spares, it won't even accept fault or bug reports, and 'advice' is a dirty word. You need the support line, though, because the little man at the end has to go and look up the authorised engineer for your area, which takes another five minutes.

It is totally unacceptable for a support line to say 'We have no ideas. If you figure it out, be sure to let us know'

Amstrad's equipment is cheap. I know it's built down to a price, and I know you get what you pay for. I can't help feeling, though, that the company is trying to make its profit on telephone support, knowing that the stuff is going to break. That, as the saying goes, is not fair.

Congratulations, Amstrad. Your award is on its way to you. I know you've worked hard for it, and you richly deserve it.

Jules' answering machine is expert in all kinds of technicalities. You can speak to it, 24 hours a day, on 0707 644185. You can also mail jules@cix.compulink.co.uk, *and he will speak to his answering machine on your behalf. He vigorously denies supporting Spurs.*



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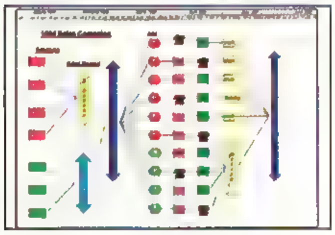

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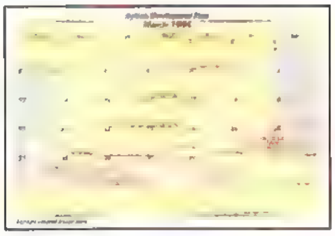

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" excellent package for the occasional project manager"

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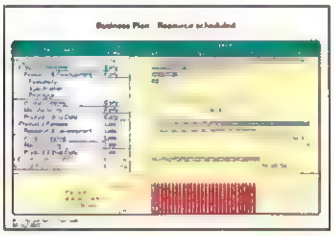

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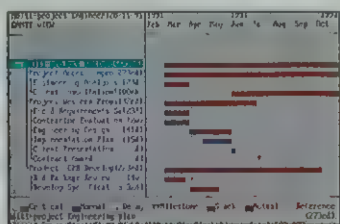

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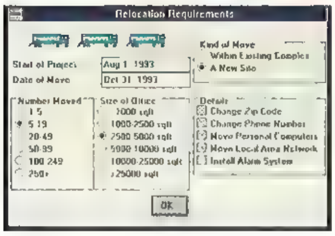

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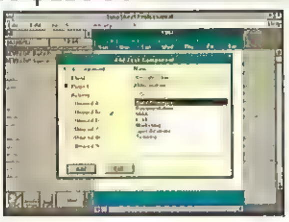

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Safer OOP With Clipper

It's no secret that you can do OOP with Clipper, but Rob Jackson is not enamoured of the syntax. Here is his safer alternative, implemented with the preprocessor.

Nantucket first launched into OOP in a modest way in 1990 with the release of Clipper 5. For those who don't know (shame on you!) this took the form of class based replacements for browsing data, editing data and the inclusion of an error system. Almost a year later, *SuperClass* appeared, followed by *Class(y)* and other add-ons that allowed you to define your own classes. Now third-party Clipper vendors are shipping libraries with run-time OOP extensions, so their products can enjoy the benefits of OOP. This amazes (and pleases) me, considering that strictly speaking Clipper is not fully object-oriented yet.

As is often the case with innovative software developments, you just can't please everyone. There are certain aspects of programming in Clipper with objects that I don't like. The purpose of this article is to show a few simple techniques that I use to overcome some of the problems that I experienced.

Error Handling

I've never liked the idea of being at the mercy of the run-time error system, (no matter how sophisticated) if I accidentally send a message to an object that it doesn't understand. I think the compiler should pick these up. Indeed, if you check error C2039 in the manual, you'll find that such an error exists... although my code never sets it off!

```
#xtranslate ;
local <dict> is Dictionary ;
=> ;
local <dict> := Dictionary():new()

#xtranslate Dictionary ;
<dict> self ;
=> ;
<dict>

#xtranslate Dictionary ;
<dict> size ;
=> ;
<dict>:size()

#xtranslate Dictionary ;
<dict> includesKey <cKey> ;
=> ;
<dict>:includesKey(<cKey>)

#xtranslate Dictionary ;
<dict> removeKey <cKey> ;
[ifAbsent <excepBlock>] ;
=> ;
<dict>:removeKey(<cKey>, ;
<excepBlock>)
```

Figure 1 - Sample Pre-processor Directives For Dictionary Class

I was finding that this error was the major cause of bugs, so I viewed this as the most critical issue as far as safer programming goes. I also decided it would be a good idea to tighten up on object initialisation to avoid the other major source of problems as well as clarifying what *initialisation* actually means.

Name Length Limit

Clipper has a 10 significant characters name limit on functions, and hence classes and their message names. This proves to be a severe limitation as your classes and inheritance relationships get more complex.

You cn rsrt 2 a vowel-less C++ style of naming convention, but I don't favour this: I much prefer to see `SortedCollection` instead of `SrtdCllctn`, as I can type the former just as quickly. Furthermore, current Clipper naming conventions tend to be more like the equivalent English words.

Object Message Syntax

I find the syntax of object-based expressions quite difficult to read, especially when methods receive multiple arguments.

For example, take a dictionary class that allows you to associate unique character keys with corresponding values. You would probably have a method that allowed you to remove keys as well as add them. It would seem sensible to call this message `removeKey` so you would send the message like this :-

```
oDict:removeKey("expenses")
```

However, what should happen if there are no expenses? Do you generate an error or simply ignore the situation? These issues should be addressed by the programmer who may decided to add an optional argument so the message may be sent thus :-

```
oDict:removeKey("expenses",;
{ || alert("no expenses")})
```

The functional style message syntax is at odds with the concept of sending messages to objects. When you start nesting expressions of this nature, it's easy to get really confused with all those brackets, colons and commas flying around.

The Key Benefits

Before we go into the detail, let's have a look at the key benefits of applying the techniques I'm about to describe.

- Message errors found during compilation instead of run-time.
- Easier to see what types of objects are being dealt with.
- Consistent object initialisation.
- More formal genericity.
- Can be used as a basis for class documentation.
- Easier to support long class and message names.
- Multiple-argument messages can be split using keywords for each argument.
- Easy way to support selective inheritance and message renaming.
- It doesn't look like Clipper code.

Because I'm such an honest chap, I'll also mention what may be viewed as the bad points :-

- Code is more verbose.

```
local list is Array
Array list add "oranges"
Array list eval ;
   { | item | qout(item)} ;
   startingAt 3 forNext 10
```

Figure 2 - Treating Arrays as Objects

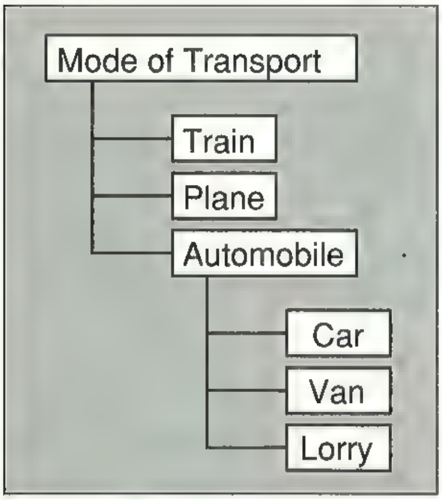

Figure 3 - Inheritance Diagram

- Requires careful management of header files.
- It doesn't look like Clipper code, if you like the look of Clipper code.

How Does It Work?

My main ally is the pre-processor, in that for every class there are a serious of `#xtranslate` directives, one for each message supported. Figure 1 shows the some of the directives I use for my basic `Dictionary` class. It should be fairly easy to see how the alternative syntax gets mapped back to standard Clipper style. Going back to the previous example I can now write the following expression :-

```
Dictionary oDict ;
 removeKey "expenses" ;
 ifAbsent ;
  {|| alert("no expenses")}
```

Since I use `#xtranslate` I can build complex nested expressions and enjoy the freedom of longer keywords. This is a departure from a command oriented approach used in some third-party object-based libraries, while combining the readability of prefixing arguments with keywords. It's also easier to see what's going on as all object references are prefixed with their type. To my mind this makes the same sense as writing `len(aNumbers)` so the reader can tell that you are dealing with an array rather than a string. In the polymorphic weakly-typed world of Clipper, I think this is even more important.

This syntax will be instantly recognised by anyone who has used the Smalltalk language, which is the origin of my idea.

```
function hubCapCost(auto)
  local result is Numeric
  if Automobile auto ;
  isDescendantOf Automobile
    result := Automobile ;
        auto numWheels * ;
      Automobile ;
        auto pricePerHubCap
  else
    // handle error
  endif
return(result)
```

Figure 4 - Hubcap Cost Routine

You cn rsrt 2 a vowel-less C++ style of naming convention, but I don't favour this

Compiler Errors

Using this technique, any unsupported message will generate a syntax error. This error will either pin-point the name of the object to which an unsupported message is being sent, or the name of a misspelt message. Either way, I find this gets me straight to the offending code, although you do need to do several compilations if there is more than one error in a statement.

Object Initialisation

Also included is the provision for immediate object initialisation when variables are declared, so you can write `local myDict is Dictionary` instead of `local myDict := Dictionary():new()`.

This does raise the question of what a class constructor should actually do. Opinions differ, but I've found the following simple guidelines provide reliable and reusable classes.

- Initialise instance variables to the correct type and state.
- Avoid calling other methods unless they do the above.
- Don't use constructor arguments.

Expanding on this, it is important to understand the notion of the type and state of an instance variable. For example, a flag used in a file class may indicate if the file is open or not, therefore its type is logical and its state is false. A more complex class may use an error log file, in which case I would tend to argue that the constructor should open the error file, as an instance may be useless without it.

The second point is the exception to the rule in cases where you may want to export the process of initialising certain instance variables, for example, the initial balance of a bank account. The important thing to remember here, is that for any method you decide to export, make sure you use it in the class itself if you need that particular service.

The third point may draw criticism, but this was originated from the way in which some OOP extensions pass constructor arguments back to the superclass. I don't think this is such a good idea as the number and types of arguments could easily differ in a subclass. The general rule of thumb is the simpler the constructor, the better.

Arrays As Objects

I have found that initialising all data types, including objects, in this way reduces errors and promotes consistency and clarity in source code, especially in programming teams. It also allows you to treat arrays as objects without having to write an object wrapper. This can make complex array handling more readable as in Figure 2.

More Formal Genericity

The techniques presented here allow generic programming, but in a more object-oriented way. For example, consider the class structure shown in Figure 3.

Suppose I'm writing a generic routine to calculate the cost of replacing hubcaps for cars, vans and lorries. If I'm writing a method (or function) to do this, I can say that the type of object should be a descendant of Automo-

```
method accCompare(acc)
  local result is Logical
  if BankAccount acc ;
  isKindOf BankAccount
    result := ;
     self:accNum == acc:accNum
  else
    // handle error
return(result)
```

Figure 5 - Account Compare Routine

bile. So I can write the routine as shown in Figure 4. This routine is quite safe in that it will handle any future descendant of that class. This makes it very clear, in quite a formal way, just how generic the routine actually is.

If you need run-time type-checking, which is advisable in Clipper, it is fairly easy to implement an `isDescendantOf` message so you can still type-check generic code.

You can also support something like operator overloading, so you can write `if BankAccount accOne == BankAccount accTwo self`. The comparison may be simply done on the account number. So, by using a directive in the header file `#xtranslate BankAccount <acc> == <acc1> => <acc>:accCompare(<acc1>)` you can emulate operator overloading. Example code for the `accCompare` method is shown in Figure 5.

Docs & Headers

How to document these new classes? Well, if you strip out the `#xtranslate` and the actual translations, and add comments on functionality and return values, you can end up with a reasonable documentation of the class interface. The downside is that you do end up having to duplicate the parent's class directives, although I've found in practice that you often need to make subtle alterations to comments and message argument types anyway.

To `#include` every class header file in every client module would be a bit if a nightmare! To counter this, I split classes into groups based on their inheritance relationships and `#include` all these files in a new version of the STD.CH header file. Then, if you're using classes, simply compile with the /U option.

Conclusion

Overall, I like using this style of coding. Even though you type more, I've found that it doesn't seem to take any longer to write code, in fact, the syntax follows the way you might think about what you need to do. As an added bonus, many potential errors and problems are reduced either because of the compiler syntax or simply because the code is more readable.

Furthermore, many of the techniques suggested here provide an insulating layer between add-on or language specific details. This will give rise to an even smoother migration path to a fully object-oriented version of Clipper, Aspen, and even other OOPLs.

EXE

Rob Jackson is a Senior Clipper Analyst/Programmer and Registered OOP Addict whose lifetime ambition is to write articles for .EXE Magazine (poor fool! - Ed). He has been programming in xBase/Clipper for over 5 years, and using OOP techniques for almost 2 years. He has spoken at several Clipper User-Group meetings around the country, mainly on the subject of OOP. He may be contacted via CompuServe on 100063,2602.

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The Secrets of DMA

In the final part of his DMA epic, Benjamin Sidle ties up his loose ends, and deals with the special considerations of PS/2 and EISA machines.

Previously in !C: I have explained the workings of the 8237 chip, and how these apply to the PC. I have also presented skeleton code for transferring data using the 8237. This month, I will deal with DMA on the more modern PC architectures. But first I must settle a problem familiar to PC programmers: that of crossing the 64 KB boundary. You may wish to have *.EXE*s May and June issues to hand, as I shall be referring back to figures.

Crossing the Boundary

The 8-bit DMA chip cannot transfer data across a 64 KB boundary. But what if the data you want to download is greater in size than 64 KB? Or it just so happens that your buffer starts so far up the page that it is forced to cross the boundary?

There are two approaches to this problem. You could calculate ahead before you even begin a transfer and see if your transfer will cross a boundary; if so, you divide the transfer into sections about the boundary. The first transfer will fill the buffer right up to the boundary, then you increase the page address by one and reload the new Page Register. You also load the Base Address Register, for whatever channel you are using, with zero (as you are now starting at the beginning of a page) and reload the count register with the number of points left to transfer (don't forget to subtract '2'). This is the approach taken in the program provided (see Figure 2).

However, this first method could cause problems if the rate at which data arrives is so fast that any temporary buffers used to store data are overrun while the various DMA registers are reprogrammed. There is a way round this providing your proposed data transfer is 64 KB or less. If you allocate twice as much memory as you need and then calculate where, if at all, the buffer crosses page boundary(s), one part of the buffer will always be big enough to accommodate your transfer without having to cross a page boundary. This method sacrifices memory in favour of speed.

Another way to improve speed would be to use two DMA channels so that you do not have to keep programming a single DMA channel to accommodate the two buffers (`BUFFER1` and `BUFFER2`). On a 286 or greater system, DMA Channel 0 could be assigned to `BUFFER1` and DMA Channel 1 to `BUFFER2`. Both channels would then be programmed into auto-initialisation mode so as they retained their Base Address and Base Count in between transfers. However this would also strongly depend on the design of the adapter board you were programming and whether it allows the selection of 2 active DMA Channels.

Function Name	Program Command	Bits Used
I/O Address Register	0h	0-15
Memory Address Register Write	2h	0-23
Memory Address Register Read	3h	0-23
Count Register Write	4h	0-15
Count Register Read	5h	0-15
Status Register Read	6h	0-7
Mode Register	7h	0-7
Arbiter Register	8h	0-7
Mask Register Set Single Bell	9h	
Mask Register Reset Single Bell	Ah	
Master Clear	Dh	

Figure 9 - Table of Extended Mode Commands

PS/2

There are some extra considerations in using DMA on PS/2's with their Micro Channel Architecture bus. For a start, channel 4 is free for DMA transfer and uses the page register at port 8FH. There are two ways of programming the DMA subsystem on the PS/2's 8237 compatible mode and Extended Mode. Compatible mode is nearly identical with that on the PC/AT: all the ports for the DMA chips and Page Registers are at the same location. The differences are that the Flip-Flop, Master Clear and Clear Mask Register are no longer available. The Base Address and Base Count Registers are written in a single 16-bit action.

In Extended mode there are two extra Registers which allow access to the extra modes available on the PS/2, as well as allowing all the conventional functions to be programmed in through these extra Registers. The first of these two Extended Mode Registers is the *Function Register* at Port 18h. This register allows you to specify the target DMA channel and the function to be programmed.

Bits 0-2 - Channel Number.
Bit 3 - Unused.
Bits 4-7 - Specify the function
(see Figure 9).

If a function requires associated data to be written to the port, this is achieved by writing to the *Extended Function Execution Register* located at Port 1Ah. The DMA chip can be entirely programmed from these two Registers. When reading or writing to the Memory Transfer Registers, the addresses are 24-bit, as the Page Registers are written as well. This single write is accomplished by using the EAX Register. In extended mode there are some extra registers available; the I/O Address Register allows the target I/O Port to be programmed in. The Arbiter Register allows the Arbitration level of channels 0 and 4 to be changed. The arbitration level of the other DMA channels are fixed, with their level being the same as their channel number (initially Channels 0 and 4 are set

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to Arbitration levels 0 and 4 respectively). Channels 0 and 4 can be programmed to any arbitration level, except of course 0Fh, which is that of the microprocessor.

The bits of the mode register are redefined in extended mode as follows:-

Bits 7, 5, 4 and **1** are reserved and must be set to '0'.
Bit 6 - When set to '0' allows 8-bit transfers, and when set to 1 allows 16-bit transfers.
Bit 3 - 0 for a Read from Memory and 1 for a Write to Memory.
Bit 2 - 0 for a Verify and 1 for a Data Transfer.
Bit 0 - 1 use Programmed I/O address, 0 set I/O address to 0000h.

ISA

On ISA machines there is a new set of page registers known as the *Upper Page Registers* (the conventional Page Registers are rebadged as the 'Lower Page Registers'). These new Page Registers are four bits long, and allow up to 256 MB to be addressed. The Upper Page Register for Channel 0 is located at port 0487h ie the Port number of the (Lower) Page Register plus a 1000 (0400h). The other Upper Page Registers are similarly located. The Lower Page Register must be written to first, as writing to it sets the Upper Page Register to zero.

EISA

For the EISA bus these Upper Page Registers are eight bits long allowing access to 4 GB of address space. Their port location is the same as for the ISA systems.

On the EISA system the DMA channels are part of the 82357 Integrated System Peripheral (ISP) chip and, although compatible with the 8237, there are some extra registers and facilities available. Channel 4 is still unavailable, being in cascade mode, but the other channels can be programmed for 8,16 and 32-bit mode. The count registers are 24 bits long. The first 16 bits are programmed via the usual count registers with the use of the Flip-Flop Register. Programming the lower 16 bits sets the upper 8 bits to zero, so they must be programmed second. The Upper Count Registers are located by adding 0400h to the corresponding 16-bit Count Register. There are also two Extended Mode Registers, one for channel 0-3 located at port 040Bh and one for channels 4-7 located at port 04D6h. The bit pattern of the Extended Mode Register is as follows:

Channel Number	Bits 7-2	Bits 15-8	Bits 23-16
0	04E0h	04E1h	04E2h
1	04E4h	04E5h	04E6h
2	04E8h	04E9h	04EAh
3	04ECh	04EDh	04EEh
5	04F4h	04F5h	04F6h
6	04F8h	04F9h	04FAh
7	04FCh	04FDh	04FEh

Figure 10 - Table of Stop Registers' Locations

Bits 1 and **0** determine the channel (00) corresponding to channel 0 or 5 etc.

Bits 3 and **2** define the transfer size: (00) - 8 bit transfer count by bytes, (01) - 16-bit count by word with the address shifted as discussed for channels 5,6 and 7 on the 8237. (10) - 32 bit transfer count by bytes. (11) - 16 bit transfer count by bytes. For this selection the address can be programmed in the conventional way aligned on an odd boundary if so desired. This will cause a partial transfer on the first and last transfer.

Bits 5 and **4** determine the speed of data transfer:

(00) - Compatible Timing, this is the slowest transfer available and is provided for DMA devices not capable of the faster speeds available.

(01) - Type 'A' Timing. This is for faster transfers using EISA memory. For 8/16 bit ISA Memory the timing will automatically revert back to Compatible Timing rates on a cycle by cycle basis. Many ISA DMA devices are able to use this Type 'A' Timing (if used with EISA memory).

(10) - Type 'B' Timing. This is for even faster transfers for 8/16 bit ISA or EISA DMA I/O devices that can work at very high I/O rates. This timing only works with EISA memory. Should ISA memory be used the timing reverts back to Compatible Timing on a cycle by cycle basis. A number of the more recent ISA DMA devices are able to use this Type 'B' Timing.

(11) - Type 'C' Timing (Burst Timing). This the fastest timing of all and is for use by EISA DMA devices using EISA memory. Up to 33 MB per second can be achieved using 32-bit memory. This timing mode is also available for 8 and 16-bit EISA DMA devices.

Bit 6 - End of Progress (EOP) Selection. This decides whether the EOP is to be used as an input(1) or output(0) signal during DMA transfer and has been added to allow data communication. If used as an input it allows a device to trigger an auto-initialisation when a given condition occurs.

Bit 7 - This determines if the Stop Register associated with the Channel is to be used(1) or not(0)

Stop Register

Each channel has associated with it a 22-bit *Stop Register* for use with a common data communication structure known as a *Ring Buffer*. This facility is only of use when the channel has been programmed in auto-initialisation Mode. The Ring Buffer is located on Double Word boundaries. The limits of this Ring Buffer are defined by the Base Address and the Base Address + Base Count Register (in bytes).

When a DMA transfer has finished, the auto-initialisation takes place and the DMA is ready to use the same area of memory again. However by now the Processor will have started to transfer data out of the Ring Buffer. It keeps track of where it has got up to in the Ring Buffer by writing to the Stop Register. When a double word is read by the processor from the Ring Buffer, that location becomes available for further DMA transfers. (NB although the Stop Register operates in double words, one can still perform DMA one byte at a time.)

When the DMA starts to transfer again, it cannot transfer above the value in the Stop Register. Should the DMA transfer reach the Stop Register, it will transfer into the memory location defined by the Stop Register, after which the Channel will be masked off.

The 22 bits used are defined on Address lines A23 - A2, so the maximum size of a Ring Buffer is 16 MB. Each of these 22-bit registers is accessed by writing to three consecutive ports (the starting port for each Channel is given in Figure 10). For the first port of each Channel only bits 7-2 are used; the contents of bits 1 and 0 are ignored.

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Chaining Registers

The final DMA EISA feature to be discussed is very useful; it allows you to transfer to or from multiple memory buffers. It makes use of the fact that the Page, Address and Count Registers have a Current Register and a Base Register (which is what allows auto-initialisation). They are both programmed simultaneously with the same value when used in the standard fashion. It should be noted that the Page Registers are located on the 82357 ISP and have both a Base and Current Register (unlike on XT, AT and ISA buses where the Page Registers only have a Current part). There are also two *Set Chaining Mode Registers* both of which are write-only. One handles Channels 0-3 at port 040Ah, the other, channels 4-7 at port 040Dh. The bit pattern is as follows:

Bits 1 and **0** determine the channel (00) corresponding to channel 0 or 5 etc.
Bit 2 - Disable (0) or Enable Chaining Mode.
Bit 3 - Programming Complete (1) or Don't Start Chaining (0).
Bit 4 - Generate IRQ 13 (0) or Generate TC (1).
Bits 5-7 - Reserved

The first step is to disable the chaining mode for the particular channel you are going to use and program the Page, Address and Count Registers in the usual way. This will set both the Base and Current Registers for these functions. Next, the chaining mode is enabled and the second set of Page, Address and Count Registers are written in the usual way. However, this time only the Base Registers are affected. When this has been done, the Chaining Mode Register is set for enable chaining and programming complete. As things stand now the Current Registers have the 'First' set of values in them and the Base Registers have the 'Second' set of values in them.

The DMA transfer may now start. When it has reached its terminal count the 'Second' set of values stored in the Base Registers are automatically moved to the Current Registers, the Enable Chaining and Programming Complete bits are reset, and the DMA continues. While the second part of the DMA transfer is in progress, the 'Third' set of values are programmed into the Base Registers, and the enable chaining bit and programming complete bits are set again.

If the second part of the DMA transfer should reach Terminal Count before the Programming complete bit is set, an overrun will probably occur. In this case, the Terminal Count bit of the Status Register and the Channel's Mask bit will be set. The Mask bit can be checked by reading the Mask Register - 0Fh for channels 0-3 (which is readable on the EISA bus). To avoid overrun, the transfer type should be set to single byte or demand transfer, as these give time for the next set of values to be programmed into the Base Registers. In Block Mode there would probably never be enough time, as the processor is locked out for the duration of the transfer. If an overrun does occur then the Page, Current, Count and Chaining mode must be reprogrammed. Figure 11 shows how to set up DMA Channel 1 for Chaining.

The signal generated when a transfer has reached its Terminal Count depends on where the new programming information for the various Base Register is to come from. If the information is to come from the host CPU, then bit 4 of the Chaining Mode is cleared, which means that an IRQ 13 will be generated. If the information is to come from an EISA master then the bit 4 is set to 1, causing a TC signal to be generated.

There are three other read-only registers concerned with chaining, in each case the bit number corresponds to the channel. The first of these registers is the *Set Chaining Mode Status Register* at port 04D4h. This shows which Channels have Chaining Mode enabled (=1). The bits are set via bit 2 of the Set Chaining Mode Register.

The *Channel Interrupt Status Register*, located at port 040Ah, indicates which Channel is the source of a DMA chaining interrupt on IRQ 13. The final register (pant, gasp!) is the *Chain Buffer Expiration Control Register* located at port 040Ch. This register shows what the result will be when a buffer is full: 0 for IRQ 13 and 1 for Terminal Count.

```
.MODEL LARGE
;
;****************************************
;  Program to demonstrate use of Chaining
;  Buffers using Terminal Count to indicate
;  end of a particular transfer.
;****************************************
;
;Chain Reg. for Channels 0-3
CHAIN_MODE_REG    EQU   040Ah
STATUS            EQU   08h
MODE          EQU   0Bh


;Byte Transfer, Add. Inc, Chan. 1
CH1_MODE_VALUE    EQU   01000101B
STATUS_VALUE      EQU   00000010B
;Disable Chaining for Channel
NO_CHAIN_SET      EQU   00010001B
;Enable Chaining for Channel 1
ENABLE_CHAIN      EQU   00010101B
;Programming Complete
CHAIN_COMPLETE    EQU   00011101B


.CODE
      PUBLIC      CHAIN
      EXTRN LOAD_REG:PROC
CHAIN        PROC  FAR
;
       MOV   AL,CH1_MODE_VALUE ;Prepare for
mode
      OUT   MODE,AL           ;and send it
;
      MOV   AL,NO_CHAIN_SET
      MOV   DX,CHAIN_MODE_REG
      OUT   DX,AL             ;Disable Chain-
ing
;
; Set up the initial set of Page, Base Address
; and Base Count Registers.
;
      MOV   AX,First_Address
      MOV   BX,First_Page
      MOV   CX,First_Count
      CALL  LOAD_REG
;
      MOV   AL,ENABLE_CHAIN
      MOV   DX,CHAIN_MODE_REG
      OUT   DX,AL             ;Enable Chaining
;
; Now program in next set of Page, Base
; Address and Base Count Registers.
; These will not be used until the first
; set have been finished with.
;
      MOV   AX,Second_Address
      MOV   BX,Second_Page
      MOV   CX,Second_Count
      CALL  LOAD_REG
;
      MOV   AL,CHAIN_COMPLETE
      MOV   DX,CHAIN_MODE_REG
      OUT   DX,AL
;
;        START DMA CODE GOES HERE
;
DMA_TEST:
      IN    AL,STATUS
      TEST  AL,STATUS_VALUE
      JZ    DMA_TEST
;
; At this point the 'Second' values in the
; Base Addresses are moved into the Current
; Registers. While the DMA is ongoing the
; 'Third' values are programmed into the Base

; Registers. If Terminal Count is reached
; before the Program Complete Bit is set then
; an over-run will occur (see Text).
;
      MOV   AX,Third_Address
      MOV   BX,Third_Page
      MOV   CX,Third_Count
      CALL  LOAD_REG
;
      MOV   AL,CHAIN_COMPLETE
      MOV   DX,CHAIN_MODE_REG
      OUT   DX,AL
;
; Etc.
;
      RET
CHAIN        ENDP
      END
```

Figure 11 - Code for use of Chaining Buffers

Conclusion

DMA is not for the faint-hearted - but neither is it hopelessly difficult, as some of the Standard Works on PCs imply. I trust these articles have shed some light and inspired some ideas on area of computing which has been neglected in the literature for too long.

EXE

Benjamin Sidle is a programmer for the Atomic Energy Authority whose remit includes protecting against viruses.

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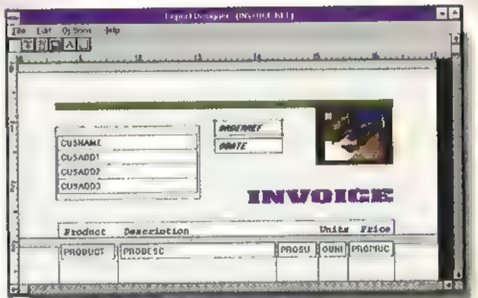

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Networked File Systems

... or why we aren't still using PIP for everything. Non CP/M fan Peter Collinson explains the evolution and workings of RFS and its popular rival NFS.

It's always interesting to speculate what might have happened had UNIX not been invented. It's certainly had a huge influence on the development of computing. I am fond of saying that all the good bits in MS-DOS were taken from UNIX and all the bad bits from CP/M. This is supposed to be a joke and is not intended to provoke the operating system zealots amongst you to start dispatching rude letters to the Editor.

I do think that UNIX proved that the hierarchical file system was the way that disks should be handled. In the late 1970s, the notion that files are stored in a tree of directories *was* revolutionary.

When networking started to happen in the 1980s, there were many attempts to join machines together in a coherent way. Most of the systems copy a single file from machine A to machine B. There are now a great many programs and suites that do this for UNIX and other operating systems: UUCP, the UK's NIFTP, the Internet protocol FTP, the ISO FTAM, and the `rcp` program.

Moving files like this suffers from several problems. First, you are copying a file, so which file is now the master copy? To keep things consistent, you have to keep track of the machine where you made the last change to the file and you have to ensure that all other copies are updated with the new contents. Second, it's hard to move the file 'context'. A file lives in a directory, is owned by a particular user, has a set of access permissions *etc*. If the file is program source, then it can refer to other files on the machine. When you move the file, you will have to move all these other files too. Finally, there may not be space on the destination machine to store the file.

A solution was needed. Several people realised that UNIX already contained the answer. When you add a new disk onto a UNIX system, you connect the file system living on that disk to the existent file tree by *mounting*. You tell the kernel that root directory on the new disk is mounted 'on top' of some other directory in the file system. The directory 'underneath' disappears and is replaced by the top of a new subtree. Effectively, you add a new branch to the file system tree in a seamlessly.

Remote Procdure Call is the key to networked file systems

The kernel arranges that the mount point is invisible. When you use a pathname to the files on the mounted disk, the kernel notices the mount point and starts to access files on the new disk.

The designers of MS-DOS decided not to adopt the single tree policy. Instead, there is a forest (or perhaps a copse) where each file system contains a separate tree. There are good reasons for this. The UNIX mount method means that the kernel has to retain state about its mounted file systems to manage the seamless transition from one disk to another. To pull a mounted floppy from a machine you have to remember to dismount the file system first. UNIX aficionados say 'unmount' after the command name that does this. The kernel may be storing some state for the floppy and so the file system on the media may be inconsistent. It's also likely that you will trash the next floppy that you put into the drive. Sun forces you to 'remember' by not giving you a physical eject button.

OK then. UNIX came ready made with the notion that new file systems would be mounted to grow the existing tree. The simple answer to the problems of file sharing over several machines was to provide access to remote files by mounting the file system on which they live. This joins the remote file system to the local machine as if you were mounting a disk and gets over all the problems of file copying.

UNIX United

The idea of joining file systems like this occurred in several places. The notion seems so obvious now, it's hard to remember that there was a time when it didn't exist. I was first exposed to a network file system when I was invited to a meeting at the University of Newcastle in the early '80s. Lindsey Marshall had joined the file systems of a set of Version 6 UNIX machines forming a networked 'single' machine that was called 'UNIX United'.

The network technology that was used was the Cambridge Ring and incidentally the code used a device driver that I had written for our own use at Kent. The Cambridge Ring was used in several UK universities at a time when it seemed that fast networking was a must and other technologies were not available.

Lindsey implemented UNIX United in an interesting way. He replaced the C library for the standard system calls by his own code. Then, by re-compiling a program, the new binary would have the ability to access files over the network. The library code knew whether a file was local or remote. It switched calls for the local file system into the local kernel. For a remote file, it parcelled up the procedure call parameters into a message that was sent to a server on the remote machine. The server executed the call and returned a response to the calling machine. The

response was passed back to the program as if the normal system call had just returned. Doing all the work in user space was an expediency. It meant that he could develop things on machines that were providing service to others. Later versions of UNIX United moved the calling code into the kernel, where it lurked just below the system call layer.

The idea that you take a procedure call, pack the parameters into a message, send it somewhere and wait for a reply is called Remote Procedure Call or RPC. The benefit is that you can take an existing program written for a set of routine interfaces and execute it using resources elsewhere. RPC is the key to all the various networked file systems.

Lindsey's approach worked well. Lindsey was helped because he was operating with a set of homogeneous machines. He didn't have to worry about byte ordering, the length of words and character sets. He was operating between UNIX systems, so he could put the standard system call interface into an RPC message. He didn't have to worry about implementing server code that would translate the UNIX system call layer into some other set of calls for a different operating system.

Meanwhile in the USA, two groups were taking the same network file system idea and looking at kernel solutions. We ended up with two systems: RFS - Remote File Sharing and NFS - the Network File System.

RFS

RFS was based on work done by Peter Weinberger for the Eighth Edition of UNIX. It was implemented by a 'File System Switch'. The File System Switch was originally designed to support distinct physical file system types on the same system, while providing a consistent interface. The UNIX system calls that pertain to files were intercepted in the top level of the kernel and passed into a service routine, one for each file system type. RFS used this to pass the UNIX system calls by RPC to a remote machine where they were executed by a server. The result was passed back via the normal system call interface to the user process.

An aim of RFS was to support the 'full UNIX file system semantics'. What does this mean? The operation of the basic system calls is obvious. In addition, there are various side effects of the way that UNIX supports its files that are important to the way that many programs work.

For example, when a process opens a file, it pulls the inode for the file into memory. The inode contains ownership data and the physical location of the file on the disk. In the in-memory copy, the kernel stores a reference count of how many processes have that file open. If the file is deleted, then its name is removed from the file system, but processes that have the file open can still read or write to it. The disk space will not be freed until the last process closes the file.

RFS was a casualty of a marketing and dogma war

Here's another example. UNIX stores its devices in the file system. RFS wanted to allow the remote machine to have access to those devices so that the remote file system would behave exactly like one that is mounted on the local machine.

RFS, then, was designed to allow UNIX systems to share files. Like UNIX United, it intercepted the system calls and sent them to a server on the remote machine. The server actioned the system calls and returned results back to the local machine. It means that the server maintains information about the state of a file: whether it is open and where we are currently writing or reading.

If the server maintains state, then we have to worry about what happens if the client or the server suddenly dies. First, the knowledge of the death must be delivered to the other interested party. This is helped by the choice of the transport protocol used to communicate between the machines. RFS uses a 'virtual circuit' to move its messages. A virtual circuit is a connection based protocol. Part of the protocol consists of handshakes and time-outs to check whether the circuit is still active. When one end dies, the other end knows within some short time.

Recovery of state depends on whether the client or server is left alive. In the client, all processes waiting for file actions are woken and their system calls return with a special error number (so much for UNIX semantics). The server tries to undo any state that the crashed client has left. It dereferences in-memory inodes and loses any extant file locks.

Starting a connection is done by the `mount` command. A server 'advertises' in a name server what file trees can be accessed by external machines and gives each tree a symbolic name. A client quotes this symbolic name when making a mount request and its kernel initialises the file system switch for the mount point.

RFS has not been popular even though it got many things right. When people talk about joining file systems together, you don't immediately think about RFS. There are several reasons for this. First, it uses proprietary protocols rather than 'open' ones. Second, it is limited for use between UNIX systems. Third, it was a casualty in a war that mixed marketing with religious dogma about stateless servers vs servers that held state. This jihad included the use of virtual circuits for connections vs datagrams. Fourth, it does not seem to have been upgraded in step with the file system. RFS is present on my Sun running SunOS 4.1.3 but does not support symbolic links. A file system mounted using RFS will not be a full citizen of the file system world. The Solaris (System V, release 4) version of RFS now supports symbolic links. The Solaris documentation is much more positive about RFS and the system provides a way of managing both RFS and NFS.

NFS

NFS is the acronym that springs to mind when people are talking about remote file systems. NFS emerged at much the same time as RFS. I well remember the 'FS wars' that dominated the Florence EUUG conference in 1986, where RFS and NFS met head on.

NFS had different design aims from the start. The most important goal was the provision of machine and operating system independence. This meant that the designers did not pick the UNIX

system call interface to form the basis of their network protocol. Instead they designed a 'virtual file system' layer and planted that in the kernel. The virtual file system layer runs on top of the 'External Data Representation', or XDR. This is a set of routines that allow canonical representation of C structures. It means that you can put some complex binary data out onto the network and be sure that the recipient will see the same data. Sun made the XDR code available on Usenet in an effort to establish a *de facto* standard. RFS uses it when necessary.

The NFS virtual file system is stateless. The server accepts an RPC request from the client, does the job, returns the result, and that's it. It remembers nothing about the state of open files, it just performs the action in the transaction and waits for more work.

Originally, this was to help with crash recovery. If a client dies, then there is no server state, so nothing needs to be done to recover the physical file system. If a server dies, then you return results to the user process saying that the file has suddenly gone away and it should stop.

The primitive NFS RPC operations sent by the client to the server are shown in Figure 1. All these operations reference a point in the server's file system by using a magic value known as the 'file handle'. The contents of this are determined by the implementation. Sun use a file system id and a file number.

NAME	ACTION
null	Do nothing, return a response
getattr	Get file attributes
setaddr	Set file attributes
lookup	Get a file handle and attributes
readlink	Read from a symbolic link
read	Read a number of bytes from a file
write	Write a number of bytes to a file
cache	Write the file cache
create	Create a file
delete	Delete a file
rename	Rename a file
link	Link to a file
symlink	Make a symbolic link
mkdir	Make a directory
rmdir	Remove a directory
readdir	Get a directory listing
statfs	Get file system attributes

Figure 1 - Primitive NFS RPC operations

As an illustration of how this works, consider a common operation: reading a file. When a UNIX process reads from a file it will use the `open` system call to open it, several `read` system calls to get the data and will finally call `close` to signal that it has finished. The `open` system call will be translated into an NFS look-up operation to obtain the file handle of the needed file. NFS does not handle slashes in file names - it's necessary to look-up one path name component at a time, so a standard `open` call can take a number of look-up iterations.

When the `read` system call is invoked from the UNIX process, the kernel will use the NFS read operation to obtain data from the file. The read operation will include the file handle that was returned by the previous look-up call. Other parameters to the read are the offset from the start of the file and the size of the chunk that is to be moved. The stateless server means that it's up to the client to remember where it is in the file and issue the appropriate RPC calls to pull the data in.

Finally, the UNIX program will invoke the `close` system call. Nothing is sent to the server, it's stateless and knows nothing about the UNIX idea of 'the open file'.

As far as possible, things are designed so that is doesn't matter if an operation is redone. This is because a client expects to retry a request if it gets no response from the server. Generally, NFS is implemented using a datagram protocol (UDP, Universal Datagram Protocol) and this is guaranteed to be unreliable. Any system along the route that the datagram packet travels is allowed to throw it away. Packets can be discarded because of congestion and a so lack of server response can mean more than just the server is down.

Given that the client can send a request several times, it's possible for the server to see the same request more than once. Since it is stateless, it will just do the operation again and send the reply. This is OK for many operations but has problems for creation and deletion of files and directories.

Stateless operation creates the need to ensure that any NFS RPC operation that changes the disk must make it onto the disk surface before the server returns a result to the calling system. If this did not happen, there would be a need for data recovery if the server crashes. Ensuring that the data is physically on the disk means that the file is in a known state, and the client can survive a server crash by simply waiting for it to come up again. However, it does means that NFS operations make the disk work very hard. There are hardware solutions to help with this.

When the client wants to start talking to a server, it needs a file handle of the remote file system. This is handled by the `mount` command in a similar fashion to RFS.

Pushing the whole problem of mounting the file system into a separate program has a great benefit. It allows the mount process to be tailored depending on the type of system that is wishing to be a client. For example, we want to impose some security checks when PC users connect with PC-NFS. A mount from a PC will go to a special mount program that asks the user for a login name and password before permitting mounts to take place. This ensures that the UNIX system enforces its idea of file security and access permissions on the unconstrained and unprotected PC.

Another protocol is used to handle file locking. Early NFS implementations did not support locking. Sun finally generated the `lockd` dæmon and its associated locking protocol. It runs on the machine that is local to the file being locked. There's a problem here when a client locks a file and then dies. The file stays locked until the client recovers and tells `lockd` to reset the locks. It is an area where using a virtual circuit would be much saner, because `lockd` could detect that the client had died and do the right thing.

NFS works and is fast. There are a several rough edges. When a server dies, it can hang any program that is dealing with files on that server. This is because the lowest levels of the file reading mechanism are trying to behave as if the remote file really is local. If a process is executing a write system call, it will be put to sleep until the call finishes. This sleep cannot be interrupted by a signal, so keyboard interrupt (perhaps Control-C) from the user

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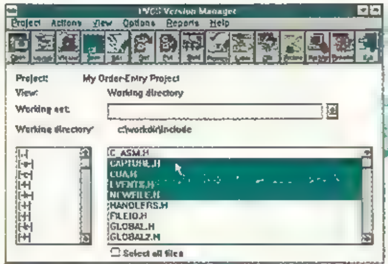

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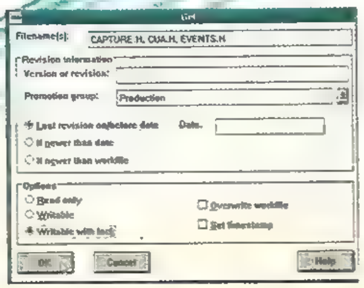

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cannot cause problems with the local disk state while the write is taking place.

This is fine for a local disk, where transactions happen very quickly and always finish. It is less fine if the file is remote and the server crashes. Your process has initiated a write to the remote machine but has not had a reply. It will keep retrying the write until the server returns. Meanwhile, you know the server is down and pound on the Control-C keys to attempt to kill your process. Nothing happens. The process is stuck in a non-interruptable wait. There is a way round this, you tell the mount process to do a 'soft' mount. Then any programs can be interrupted in mid system call by Control-C. It's possible for this to have a deleterious effect on the file at the other end.

NFS has never handled mapping of numeric user id's between systems. It demands that the same password file lives on all machines. Recall that UNIX maps your login name into a numeric value via the password file - a *uid*. RFS and UNIX United recognised that the notion of the universal uid space is not terribly practical and provide a way of equating uids on different machines. Sun chose another route, providing the Network Information Service (NIS). NIS used to be called 'Yellow Pages' until British Telecom became belligerent about its trade-mark. NIS is not a distributed database, but a way of making the password look-up on one machine go off and interrogate another. This is fine until your password server crashes, and the whole network dies because it cannot get passwords. Some people think NIS is the best thing since sliced bread, and other people decry its use.

Where are we now?

NFS is a fact of life. We all adapt to its problems and live with the various bodges that have been created to make things work. PC-NFS is very popular. RFS is not dead.

I like the notion of network file systems. I was pleased to buy an MS-DOS ISO-9660 CD-ROM, throw it into the CD reader on my Sun, export the file system and access it on my MS-DOS machine as drive `L:` using PC-NFS. I am less enamoured when it is time to take a dump of the disk on MS-DOS machine and I cannot directly access the QIC-150 tape drive on my BSD/386 box because NFS does not permit access to remote devices.

However, networked file systems make many things possible that would otherwise be difficult. The ability to share files on different machines means that you have to buy fewer physical disks. It has made large networks of disk-less workstations a practical reality. Its influence on the world of workstation based computing has been immense.

EXE

Peter Collinson is a freelance consultant specialising in UNIX. He can be reached electronically as `pc@hillside.co.uk` *(although your mailer might be happier to put the address the other way round) or by phone on 0227 761824.*

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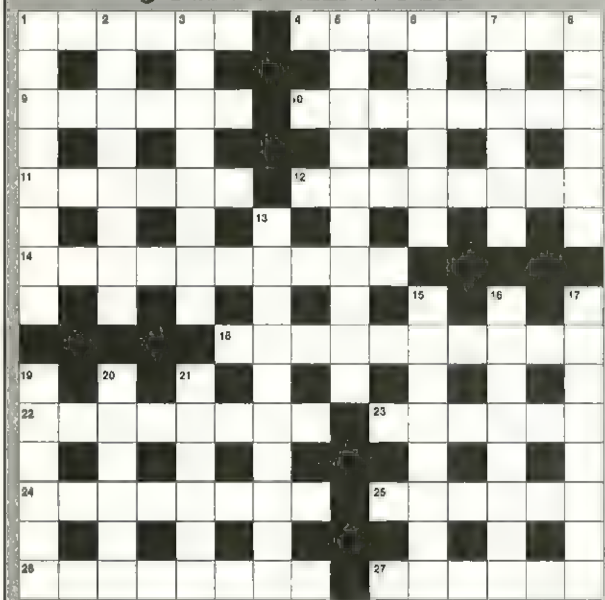

.EXEword compiled by Eric Deeson

ACROSS

1 I'm in a do about a checking system (6)
4 Trivalent impurity (8)
9 Hardware belonging to us strictly speaking (6)
10 Output units like Guys (8)
11 Noted in a 1-D array when off balance...(6)
12 ...and fussy as the program did to the data (8)
14 Simple like the items in a structure (10)
18 Hopeful output of a maximum efficiency program? (10)
22 Exhibits screens (8)
23 Without a key, take a lan to...(6)
24 ...test thoroughly what a variable holds (8)
25 Vote against the final version of the program (6)
26 What GEM and such replace (8)
27 Made a home inside several loops (6)

DOWN

1 Processing offered by transputers (8)
2 Take account of the most central store (8)
3 Made the code more efficient? (8)
5 Home of silicon valley (10)
6 Admission that sent about two orientals (6)
7 Output of the elements of a tree I hear (6)
8 Stay in store about a team (6)
13 How to pass through a loop of refinery (4,3,4)
15 Bits able to become a flip flop (8)
16 Least productive part of the road where you may sit on set (8)
17 Formed a product like a 3D artist (8)
19 Final element of a sum that keeps its value (6)
20 Tries to produce chunks of good text (6)
21 Show off negative beginning in apartment (6)

L	A	T	E	N	C	Y		D	E	C	I	M	A	L
E		E		A		O		O		A		U		O
A	T	L	A	S		U	N	D	E	R	F	L	O	W
D		E		A		N		G		T		T		N
I	N	G	O	T		G	U	I	D	E	L	I	N	E
N		R		I		E		N						S
G	R	A	M	M	A	R		G	O	B	L	I	N	S
		P		E						U		N		
A	P	H	A	S	I	A		S	I	L	I	C	O	N
R						U		U		K		R		O
C	O	L	L	E	C	T	O	R		S	W	E	A	T
H		E		A		O		P		T		M		I
I	D	E	N	T	I	C	A	L		O	L	E	I	C
V		C		E		U		U		R		N		E
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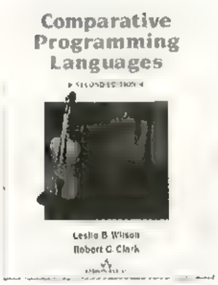

The prospect of making a forced exit from my job prompted me to draft a CV. I began with a working knowledge of Modula-2 and a whizzo text editor (written, incidentally, in Modula-2) under my belt...Alas, no potential employer would consider anyone without five years solid C/C++ - with typecast scars to prove it. Dwelling on this miserable situation it occurred to me that: 'Although two languages may seem to be superficially very different, they often have many more similarities than differences.' Actually, it didn't occur to me at all: the quote is take from *Comparative Programming Languages* by Leslie Wilson and Robert Clark.

The authors discuss issues such as the relative merits of early/late binding of variables, the different methods of passing parameters to functions and exception handling by presenting the methods employed in several languages side-by-side. Common traps such as the different behaviour of the `FOR` statement are also covered. I must admit to being startled by the discovery that, while the value of the loop counter variable is valid outside a `for` loop in bad-boy C, goody-two-shoes Pascal leaves it in an undetermined state.

The object-oriented approach to programming is compared to Ada's mechanism for data abstraction. The authors draw parallels from the C++ and Eiffel camps. In addition, Smalltalk gets a brief mention, although its historical significance is overlooked. Apologies to Xerox-Parc.

Wake up call to lambda calculus addicts! This book doesn't just cover the family of imperative languages. It looks at functional programming too. I can recollect sad (wasted) college days labouring over the unreadability of LISP. Don't get me wrong. I do appreciate the power of these languages. The book's introduction to ML, a new, easy to read, statically typed language has rekindled my enthusiasm for this type of computing.

Other types of programming covered include: logic programming in Prolog and concurrent programming in Ada, Occam and C (using UNIX pipelining).

Instead of dedicating a chapter to each language, *Comparative Programming Languages* develops and builds upon common principles. What this means to the reader is that it isn't possible to glean a working knowledge of a given language from reading a single chapter. However, the material is given in a way which makes it easier to translate from one language to another.

Title: Comparative Programming Languages *Pages: 374*
Authors: Leslie B Wison & Robert G Clark *Price: £21.95*
Publisher: Addison-Wesley *ISBN: 0-201-56885-3*

Soft Spanners

Under DOS, when an off-the-shelf package lacks some level of functionality, a programmer must choose between writing a standalone program or buying a new package to perform the job in question. UNIX programmers have another option: they can string commands together, using a technique called pipelining, to achieve the desired result (in theory). In his book, *Building Custom Software Tools and Libraries*, Martin Stitt looks at the various methods employed in writing utility software for MS-DOS.

But this isn't a book about producing specific utilities. The author concentrates instead on exposing the techniques involved in writing these tools. When should one opt for a TSR or device driver in preference to a standalone utility? What are the pros and cons of using UNIX-style pipelining for filters.

Code reuse is an important theme throughout the book. Along with the obligatory discussion of object libraries, the author side-tracks with a look at techniques involving source code include files, TSR libraries and ending with a brief overview of the DLL mechanism. An in-depth review of how global variables are linked in C and assembler, in conjunction with an explanation of the object file format, goes some way to revealing the mysteries of the linker.

On the question of writing TSRs and device drivers: there's a good assembler implementation of stack swapping (necessary for reëntrant code) and a utility for generating correctly ordered segments when mixing assembler with a high-level language. Segments must be ordered such that the resident portion of the TSR is kept separate from the initialisation part.

Other highlights include: an in-depth look at how function hooks can be added to a keyboard input routine to achieve multi-threading and mouse emulation; parsing command-line arguments and an example of file and directory searching.

Throughout the book, code is given in C, assembler and pseudocode (where appropriate). Although primarily aimed at C and assembler programmers, thanks to the peusdocode listings, those readers from other programming backgrounds should find little difficulty adapting the routines presented.

Building Custom Software Tools And Libraries attempts to cover several books worth of advanced programming techniques in 300 pages. As such, there are some topic areas which have been given less than complete coverage, rendering it unsuitable as a bookshelf reference. But as an insight into writing such software, it is an excellent buy. **CS**

Title: Building Custom Software Tools and Libraries *Pages: 272*
Author: Martin Stitt *Price: £23.50*

Books Received This Month

Introduction to Parallel Processing	Bruno Codenotti Mauro Leoncini	Addison-Wesley	£21.95	0-20156887-X	pp272
Eiffel, an introduction	Panos Elivadas Christopher Wand	Prentice Hall	£19.95	13-175712-1	pp698
C for Engineers	Brian Brammer Susan Bramer	Hodder & Stoughton	£16.99	0-340-57014-8	pp374

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ADVERTISERS INDEX

STOB Larn yasel programmin!

Once a decade, a single product redefines the parameters of programming practice. That moment has now arrived. From our extensive software laboratory, located high above Chiswick on the 25th floor of the .EXE Towers, comes a new concept in programming languages.

The Background
You will recall that Kernighan and Ritchie developed the C language from BPCL to simplify the construction of the UNIX operating system. Our language was developed one evening from ten pints of brown ale. The idea was to distract the author from a strong feeling of nausea that was afflicting her (didn't work). From these humble origins, the product has matured to the point where we feel able to release it onto an unsuspecting world.

The Language
GEORDIE - the name is an acronym for 'Gulping Excessively Often Ruins Decent Indian Edibles', in memory of another incident the night the language was born - is surely the most versatile and powerful of programming languages. It is adaptable to nearly all applications from authoring to astronomy, and from systems to simulation. Like BASIC it's easy to learn, like Ada it has facilities to handle interrupts and multi-tasking events, and like FORTRAN it has seven letters in its name. Consider this fragment of pseudo code, part of a real time fire-prevention system:

```
IF fire detected THEN
DO take-fire-prevention-action
```

Here is the same fragment of code in GEORDIE:

```
If ya ganna smork ya tab in ear,
ah'll belt ya from ear to Geeatsheed, mun
```

Like COBOL, GEORDIE was designed to be as similar to natural language as possible. We have made very few concessions to the compiler writers, although the symbol mun is used as a statement separator - equivalent to the semicolon in Pascal. Nobody would really speak GEORDIE, but we think it's a darn close-run thing!

The Competitors
GEORDIE beats its rivals hands down. Consider this pseudo code:

```
FOR each item in Shopping-List array
Do print item
```

Here is the same program coded in Cockney Rhyming BASIC:

```
10 FOR MINCEPIE = 1 TO MAXLIST
20 MURRAY MINT SLIST$(I)
30 SORELY VEXED I
```

Finally, here it is in GEORDIE:

```
Tell us wha ya gerrin in for dinna, mun
```

Need we say more?

The Package
You get a lot more than a simple compiler with GEORDIE. There's an interpreter so that applications can be developed interactively. Forget obsolete prompts like 'ok' and 'READY', when you see the line 'What fettle, petal?' you know you're working with the market leader. Also free with the compiler comes a complete programmer's environment - and we aren't talking about a text editor and a manky MAKE utility. GEORDIE is bundled with a copy of Scott Dobson's definitive work 'Larn Yasel Geordie', a black and white scarf and a couple of crates of the aforementioned electric soup.

To get your copy of GEORDIE, send a cheque for a lot of money to V STOB, c/o .EXE, Chiswick. GEORDIE. It's champion, man.

(Thanks to the Tait family for programming help.)
This is a second in a short series of Stob repeats. We thought it was rather appropriate to our cover matter! It first appeared in December 1988.

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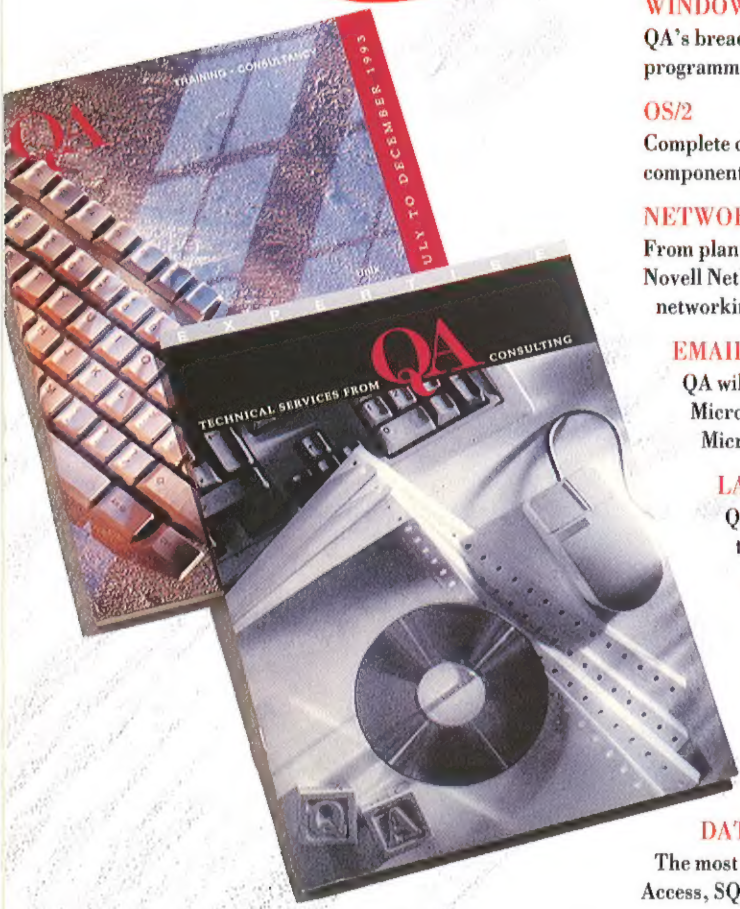

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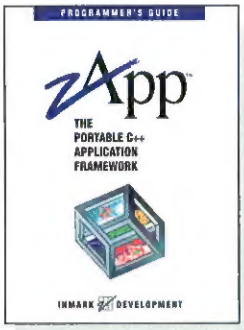

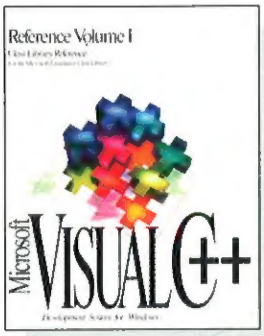

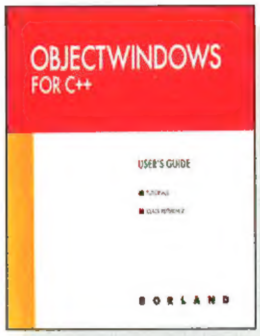

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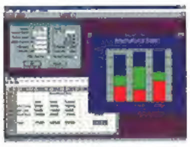

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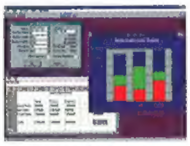

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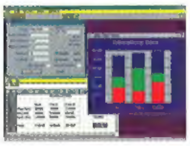

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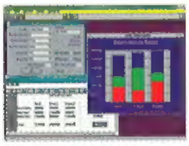
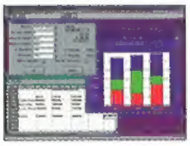


UNIX X/MOTIF



DOS GRAPHICS

DOS TEXT

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